CHITKARA UNIVERSITY

CRIO

CHITKARA UNIVERSITY PUBLICATIONS

ICAMSF-2025
1st International Conference on Advanced Materials for Sustainable Future

Abstract Book Proceeding

International Conference on Advanced Materials for Sustainable Future

(ICAMSF-2025)

28th-29th March, 2025

Venue: Chitkara University, Rajpura, Punjab, India

Organised By

Centre for Research Impact and Outcome
Chitkara University, Rajpura, Punjab, India

In Association With

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Edited By

Dr. Jitendra Kumar Katiyar | Dr. Sanjhi Paliwal | Dr. Seema Singh

Dr. Chingakham Chinglenthoiba | Dr. Ankit Sharma

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Preface

The International Conference on Advanced Materials for Sustainable Future (ICAMSF-2025), themed "Energy, Efficiency, Economy for Sustainability," promises to be a landmark event for researchers, industry leaders, and policymakers dedicated to advancing sustainable materials. Hosted by the Centre for Research Impact and Outcome at Chitkara University from March 28th to 29th, 2025, this conference will focus on the crucial role of advanced materials in shaping a more sustainable world. Attendees will engage in discussions on the current practices and challenges associated with sustainable materials for extreme environments while exploring advanced methodologies that improve efficiency and enhance the longevity of materials and machining components. ICAMSF-2025 will provide a platform to showcase cutting-edge innovations in materials science, processes, and manufacturing, with a strong emphasis on sustainability. Additionally, manufacturers will have the opportunity to present their latest products and services, highlighting industry advancements. The conference will also delve into the profound influence of sustainability in material science, examining its impact on daily life and the economic growth of nations.

Chitkara University, established in 2010 by the Punjab State Legislature under "The Chitkara University Act," is a government-recognized institution with the authority to confer degrees as per the UGC Act, 1956. Situated 30 kilometres from Chandigarh on the Chandigarh–Patiala National Highway, the university offers a wide range of multidisciplinary programs designed to be industry-relevant. Renowned as one of the best private universities in North India, Chitkara University provides educational services in business management, nursing, medical laboratory technologies, computer science, electronics, mechanical engineering, hotel management, and architecture. The university's strong national and international collaborations, robust on-campus recruitment, and cultural diversity attract students from across the globe, enriching the academic experience.

Centre for Research Impact and Outcome (CRIO) cultivates and fosters interdisciplinary high-impact research in partnerships with external organizations, industry partners, government agencies, and community groups to amplify the impact and outcome of research. Implementing strategies to enhance the visibility and dissemination of the university's research outputs through various channels such as publications, conferences, research projects, IPR, and research labs.

The primary objectives of ICAMSF-2025 encompass a broad spectrum of topics aimed at advancing sustainable materials. The conference will facilitate in-depth discussions on current practices and challenges in utilizing sustainable materials for extreme environments, addressing the need for resilient and high-performance materials capable of withstanding harsh conditions. It will also explore cutting-edge methodologies and best practices that can significantly improve efficiency, reduce waste, and enhance the lifespan of materials and machining components, ensuring long-term sustainability in industrial applications. Furthermore, ICAMSF-2025 will serve as a dynamic platform to showcase breakthroughs in materials, processes, and sustainable manufacturing techniques, allowing researchers and industry professionals to exchange knowledge on recent innovations. The event will also provide manufacturers with a valuable opportunity to display their state-of-the-art products and services, fostering collaborations that drive technological advancements. Another crucial aspect of the conference is to examine the impact of sustainability on material science, exploring how the development and adoption of sustainable materials influence industries, economies, and daily life. By focusing on these critical areas, ICAMSF-2025 aims to pave the way for a more sustainable future by bridging research, innovation, and industrial applications.

Chairperson and Co-Chairperson

CHITKARA UNIVERSITY
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Message

"Education is not just about acquiring knowledge; it's about fostering innovation, creativity, and responsible citizenship. At Chitkara University, we believe in empowering individuals to excel and contribute meaningfully to society. It gives me immense pleasure to announce that the Centre for Research Impact and Outcome, Chitkara University, Punjab, is hosting the **International Conference on Advanced Materials for Sustainable Future (ICAMSF-2025)**

This International Conference on Advanced Materials for Sustainable Future (ICAMSF-2025) vision is to facilitate communication among scholars and practitioners engaged in an extensive spectrum of topics in sustainability, energy, and advanced manufacturing. The platform explores various engineering domains that include sustainable and material engineering and green energy technologies. It places a strong emphasis on sustainable development and encourages diverse methodologies to tackle field complexities.

I am glad to know that the **Centre for Research Impact and Outcome** (CRIO), Chitkara University, Punjab is organizing an international conference on International Conference on Advanced Materials for Sustainable Future (ICAMSF-25) from 28-29th of March 2025. I am confident that the discussion and research present here will help propel the field towards shaping the future for all.

This conference represents a convergence of ideas and innovation, where minds from diverse fields unite to share knowledge, foster collaborations and inspire each other. In the face of global challenges related to promoting sustainability and advanced technologies. The discussion will focus on key areas covering the major goals of SDGs.

I extend my sincere thanks to all the distinguished speakers, sponsors and all the attendees for contributing to this enriching experience. Last but not the least, I congratulate all the organizing teams on this amazing effort. I am confident that the knowledge shared, and collaboration made here will have a lasting impact on the future of sustained world.

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I welcome all the experts, delegates and future scientists and wish you all the best for this grant event. I am sure that the ideas exchanged will ignite new collaborations and innovations and lead to transformative advancements in advanced materials for a sustainable future.

I extend my best wishes to all the participants and organizers for an inspiring and successful conference. I hope you have a wonderful time at Chitkara University- where *innovation meets excellence.*

Jai hind!

Dr. Madhu Chitkara

Pro-Chancellor

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Message

It is with great enthusiasm and immense pride that I extend my warmest greetings to all participants, esteemed speakers, and distinguished guests of the **International Conference on Advanced Materials for Sustainable Future** (ICAMSF-2025), taking place on March 28-29, 2025, at Chitkara University, Punjab. This conference is a testament to the power of innovation, collaboration, and academic excellence, bringing together brilliant minds to explore groundbreaking advancements in sustainable materials.

The theme of this conference which is on Advanced materials for a sustainable future excites me since its the need of the hour. Material engineering for sustainable purposes is an important area of research that has a significant impact on achieving the SDG in the coming years.

I wholeheartedly congratulate the organizing team for their tireless efforts and vision in orchestrating this prestigious event. Their dedication and commitment have created a platform that will not only showcase cutting-edge research but also inspire transformative ideas that can shape the future of sustainable technologies. The discussions, collaborations, and discoveries that will emerge from this conference have the potential to drive real-world impact and contribute meaningfully to global sustainability goals.

I extend my best wishes for a highly successful and intellectually stimulating conference. May ICAMSF-2025 be a catalyst for innovation, fostering partnerships and pioneering solutions for a sustainable future!

Prof. Sandhir Sharma
Vice Chancellor
Chitkara University, Punjab

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Message

In all humility and with great privilege, I extend my warmest greetings to all esteemed participants, distinguished speakers, and dedicated organizers of the **International Conference on Advanced Materials for Sustainable Future** (ICAMSF-2025), to be held on March 28-29th, 2025, at Chitkara University, Punjab. This prestigious conference stands as a beacon of knowledge and innovation, bringing together researchers, academicians, and industry experts to explore cutting-edge advancements in sustainable materials science.

I extend my heartfelt congratulations to the organizing team for their unwavering dedication and meticulous efforts in curating this remarkable event. Their commitment to fostering intellectual exchange and collaboration will undoubtedly contribute to groundbreaking research and sustainable technological progress. I am confident that ICAMSF-2025 will serve as a dynamic platform for inspiring discussions, meaningful partnerships, and transformative ideas that will shape the future of advanced materials.

This souvenir stands as a symbol of the collective passion, dedication and innovation investment in this cause. It is a reminder of the progress we have made and the challenges that remain ahead. Each breakthrough we achieve is a step closer to a better and sustainable future.

I would also like to express my sincere gratitude to Chitkara University for granting the permission to host this prestigious event and providing a space where innovation and sustainability converge. A big shout-out to the organizing team for their tireless efforts, dedication, and meticulous planning in ensuring the success of this conference. Their hard work has been instrumental in bringing together experts from around the world to share knowledge and drive impactful change.

I welcome all the experts, delegates and future scientists and wish you all the best for this grant event. Wishing all participants an enriching and fruitful experience. May this conference lead to impactful discoveries and lasting contributions toward a more sustainable world.

Dr Amit Mittal
Pro Vice Chancellor-Research Programs
Chitkara University, Punjab, India

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Defence Institute of Advanced Technology (DIAT), Deemed to be University-Pune

(An Autonomous Organization, Department of Defence Research & Development, Ministry of Defence, Govt. of India)

Message

I am very happy to know that the International Conference on Advanced Materials for Sustainable Future (ICAMSF-2025), is taking place on March 28-29, 2025, at Chitkara University, Punjab. This conference stands as a crucial platform for exploring cutting-edge advancements in sustainable materials, bringing together experts from academia, industry, and research institutions to drive impactful innovation.

At DIAT, we recognize the critical role that advanced materials play in defense, aerospace, and strategic applications, especially in enhancing sustainability, efficiency, and resilience. ICAMSF-2025 provides a unique opportunity to engage in meaningful discussions on the latest research, emerging challenges, and breakthrough technologies that can redefine the future of material science.

I extend my sincere gratitude to **Chitkara University** for hosting this prestigious event and to the **organizing committee** for their dedication in creating a platform that fosters collaboration and knowledge exchange. I look forward to engaging discussions, insightful presentations, and the opportunity to contribute to this important dialogue on sustainable materials.

Wishing all participants a highly successful and enriching conference!

Dr. B.H.V.S. Naryana Murthy

Vice Chancellor

DIAT (DU) Pune

CHITKARA UNIVERSITY

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Message

It is our great pleasure to welcome all esteemed speakers, participants, and industry experts to the *International Conference on Advanced Materials for Sustainable Future (ICAMSF-2025)*, which will take place on **March 28-29, 2025**, at **Chitkara University in Punjab**. The conference boasts an impressive lineup of distinguished individuals who will enrich our discussions. We are thankful to all distinguished speakers from various international and national institutions as well as all the participants for being part of this grant event. We are confident that this opportunity to explore new frontiers of knowledge and innovation, contributing to the advancement of sustainable engineering for a better future. Furthermore, we are proud to announce our publication partners include 7 special issues from Sage, Emerald, Wiley, Water Emerging Contaminants & Nanoplastics (WECN), Beilstein Institut, Lecture notes in mechanical engineering, Springer publication. These special issues are all SCI and Scopus indexed journal. The support of the Anusadhan National Research Foundation (ANRF), Defence Research and Development Organisation (DRDO) and Council of Scientific and Industrial Research (CSIR) as our esteemed government sponsorship partner underscores the significance of this event in the realm of research and development. We are also grateful to SKUEM Water Projects Pvt. Ltd for the generous support of our Industrial Sponsorship Partner.

We would like to express my heartfelt appreciation to **Chitkara University** for hosting this prestigious event. We are especially grateful to our patron, **Prof. Amit Mittal,** for his guidance during this journey. A special thanks goes to our remarkable behind-the-scenes team the unsung **heroes** whose dedication and effort have made this conference well-organized and impactful. We are confident that this event will spark insightful discussions, encourage meaningful collaborations, and inspire groundbreaking ideas. In conclusion, we extend my best wishes to all participants for a productive and enriching experience at ICAMSF-2025.

Wishing everyone a successful and inspiring conference!

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Dr. Jitnedra Kumar Katiyar
Dr. Seema Singh
Dr. Ankit Sharma

Co-Chairpersons
Dr. Sanjhi Paliwal
Dr. Chingakham Chinglenthoiba

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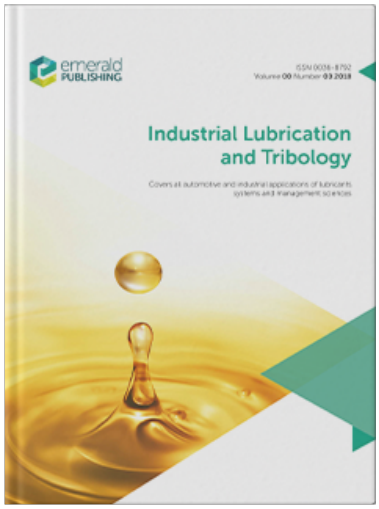

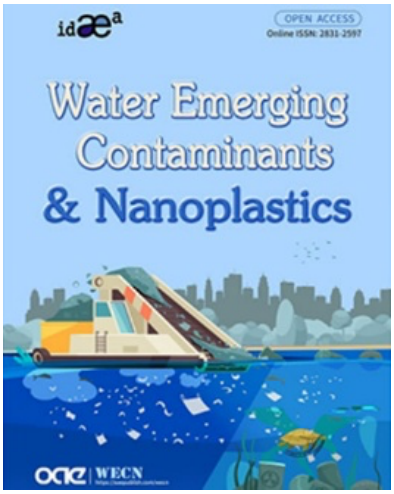

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  National Institute of Technology Calicut, Kerala
- **Dr. Shailesh Kumar Singh**, Senior Scientist, CSIR-Indian Institute of Petroleum

Schedule

Time		Day 1 (28-03-2025) (Pulitzer Hall, Picasso Block)
9:00 AM-10:00AM		**REGISTRATION**
10:00AM-11:30 AM		**INAUGURATION AND GROUP PHOTO**
11:30 AM -12:00PM		**HIGH TEA**
12:00PM-1:30 PM		**Session Chair (S1)** Prof TVVLN Rao, Assam downtown University Guwahati and Dr. Jitendra Kumar Katiyar, Chitkara University **Plenary Talk 1** Prof. Dineshsingh Thakur, Director, Planning & Policy & NEP, Defence Institute of Advanced Technology (DU), DRDO, Pune, Maharashtra **Plenary Talk 2** Dr. M Ravisankar, Professor and HOD, Department of Mechanical Engineering, Indian Institute of Technology Tirupati **Plenary Talk 3** Prof. V. C. Srivastava, Dean of International Relations, Department of Chemical Engineering, Indian Institute of Technology Roorkee, India
1:30 PM - 2:30 PM		**LUNCH**

Time 2:30PM-4:35PM	**Offline**		**Time**	**Online**								
	S2 Session Chair: LN & MKS	**S3 Session Chair: RK & GJ**		**S4 Session Chair: AS**	**S5 Session Chair: NGN**	**S6 Session Chair: AKS**	**S7 Session Chair: SP**	**S8 Session Chair: TVKG**	**S9 Session Chair: CC**	**S10 Session Chair: TVVLNR**	**S11 Session Chair: PCV**	**S12 Session Chair: VKP**
2:30PM-2:55 PM	**Keynote 1** Dr Pooja Devi CSIR-CSIO Chandigarh	**Keynote 2** Dr. Asheesh Kumar CSIR IIP Dehradun	2:30PM-2:55 PM	**Keynote 3** Sunny Zafar IIT Mandi	**Keynote 4** Prof. Laura Clarizia UNF Italy	**Keynote 5** Dr. Mohamad Ali Ahmad UiTEM Malaysia	**Keynote 6 Dr.** Ramanpreet Kaur JSI Slovenia	**Keynote 7** Dr. Saqib Gulzar CSU Pueblo	**Keynote 8** Dr. Priya K L TKM Kerela	**Keynote 9** Prof. Binnur Sagbas YTU Turkey	**Keynote 10** Prof. Manas Das IIT Guwahati	**Keynote 11** Dr. Amrish K. Panwar DTU Delhi
2:55PM-3:15PM	**Invited Talk 1**	**Invited Talk 2**	2:55PM-3:05PM	ICAMSF-37	ICAMSF-57	ICAMSF-73	ICAMSF-91	ICAMSF-104	ICAMSF-130	ICAMSF-150	ICAMSF-163	ICAMSF-176

	Dr. Anoop Verma TU Patiala	Dr. Ranjeet Kumar Sahu NITK Surathkal	3:05PM-3:15PM	ICAMSF-40	ICAMSF-59	ICAMSF-74	ICAMSF-92	ICAMSF-105	ICAMSF-134	ICAMSF-151	ICAMSF-164	ICAMSF-177
3:15PM-3:25PM	ICAMSF-51	ICAMSF-132	3:15PM-3:25PM	ICAMSF-43	ICAMSF-60	ICAMSF-75	ICAMSF-93	ICAMSF-106	ICAMSF-135	ICAMSF-153	ICAMSF-168	ICAMSF-180
3:25PM-3:35PM	ICAMSF-53	ICAMSF-141	3:25PM-3:35PM	ICAMSF-44	ICAMSF-63	ICAMSF-76	ICAMSF-94	ICAMSF-108	ICAMSF-136	ICAMSF-155	ICAMSF-169	ICAMSF-183
3:35PM-3:45PM	ICAMSF-84	ICAMSF-147	3:35PM-3:45PM	ICAMSF-45	ICAMSF-64	ICAMSF-79	ICAMSF-95	CAMSF-109	ICAMSF-137	ICAMSF-156	ICAMSF-170	ICAMSF-184
3:45PM-3:55PM	ICAMSF-85	ICAMSF-157	3:45PM-3:55PM	ICAMSF-46	ICAMSF-65	ICAMSF-81	ICAMSF-96	ICAMSF-110	ICAMSF-138	ICAMSF-158	ICAMSF-171	ICAMSF-185
3:55PM-4:05PM	ICAMSF-100	ICAMSF-190	3:55PM-4:05PM	ICAMSF-47	ICAMSF-66	ICAMSF-82	ICAMSF-97	ICAMSF-116	ICAMSF-142	ICAMSF-159	ICAMSF-172	ICAMSF-186
4:05PM-4:15PM	ICAMSF-107	ICAMSF-203	4:05PM-4:15PM	ICAMSF-50	ICAMSF-69	ICAMSF-83	ICAMSF-98	ICAMSF-118	ICAMSF-143	ICAMSF-160	ICAMSF-173	ICAMSF-187
4:15PM-4:25PM	ICAMSF-117	ICAMSF-205	4:15PM-4:25PM	ICAMSF-52	ICAMSF-71	ICAMSF-87	ICAMSF-99	ICAMSF-125	ICAMSF-145	ICAMSF-161	ICAMSF-174	ICAMSF-188
4:25PM-4:35PM	ICAMSF-127	ICAMSF-224	4:25PM-4:35PM	ICAMSF-56	ICAMSF-72	ICAMSF-89	ICAMSF-103	ICAMSF-129	ICAMSF-149	ICAMSF-162	ICAMSF-175	ICAMSF-189
4:35PM-4:50PM		**TEA**										
Time 4:50PM-6:45PM	**S13 Session Chair: SS & AK**	**S14 Session Chair: JK & SV**	**Times**	**S15 Session Chair: RKS**	**S16 Session Chair: MFUH**	**S17 Session Chair: RS**	**S18 Session Chair: AR**	**S19 Session Chair: HK**	**S20 Session Chair: AKS**	**S21 Session Chair: AK**	**S22 Session Chair: SHD**	**S23 Session Chair: MIUH & SJ**
4:50PM-5:15PM	**Keynote 12** Dr. Vikas Kumar Sangal MNIT Jaipur	**Keynote 13** Dr. Sushil Kumar Kansal, PU Chandigrah	4:55PM-5:05PM	ICAMSF-192	ICAMSF-209	ICAMSF-225	ICAMSF-245	ICAMSF-259	ICAMSF-271	ICAMSF-287	ICAMSF-315	ICAMSF-329
			5:05PM-5:15PM	ICAMSF-193	ICAMSF-210	ICAMSF-227	ICAMSF-246	ICAMSF-260	ICAMSF-273	ICAMSF-288	ICAMSF-317	ICAMSF-331
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5:25PM-5:35PM	ICAMSF-238	ICAMSF-290	5:25PM-5:35PM	ICAMSF-196	ICAMSF-213	ICAMSF-229	ICAMSF-250	ICAMSF-262	ICAMSF-276	ICAMSF-292	ICAMSF-320	ICAMSF-333

5:35PM-5:45PM	ICAMSF-240	ICAMSF-302	5:35PM-5:45PM	ICAMSF-197	ICAMSF-215	ICAMSF-234	ICAMSF-251	ICAMSF-264	ICAMSF-277	ICAMSF-294	ICAMSF-321	ICAMSF-336
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7:00PM-9:30PM		**CULTURAL PROGRAM FOLLOWED by GALA DINNER**										

Time		**Day 2 (29-03-2025) (Pierre Hall, Le Corbusier Block)**
9:30 AM-11:30AM		**Keynote Talk (S24)** **Session Chair** Dr. Rina Angel, Chitkara University and Dr. Jitendra Kumar Katiyar, Chitkara University **Keynote Talk 14** Prof. Harish Hirani, Ex Director, CSIR-Central Mechanical Engineering Research Institute (CSIR-CMERI) and Senior Professor, Department of Mechanical Engineering, Indian Institute of Technology Delhi **Keynote Talk 15** Dr. SAJITH V, Professor, Department of Materials Science and Engineering, National Institute of Technology Calicut **Keynote Talk 16** Dr. TVK Gupta, Associate Professor, Department of Mechanical Engineering, Visvesvaraya National Institute of Technology Nagpur
11:30 AM -11:45AM		**TEA**

Time 11:45AM -1:30PM	**Offline**		**Time**	**Online**								
	S25 Session Chair: AKS & TVKG	**S26 Session Chair: PCV & RKS**		**S27 Session Chair: NS**	**S28 Session Chair: VKP**	**S29 Session Chair: BS**	**S30 Session Chair: RT**	**S31 Session Chair: DG**	**S32 Session Chair: VS**	**S33 Session Chair: SM**	**S34 Session Chair: AM**	**S35 Session Chair: AA**

11:45AM-12:10 PM	**Keynote 17** Dr. Harish Kumar NIT Delhi	**Keynote 18** Dr. Arun Singh VNIT Nagpur	11:50AM -12:00PM	ICAMSF -348	ICAMSF -360	ICAMSF -375	ICAMSF -397	ICAMSF -416	ICAMSF -434	ICAMSF -454	ICAMSF -473	ICAMSF -493
			12:00PM-12:10PM	ICAMSF -350	ICAMSF -361	ICAMSF -377	ICAMSF -399	ICAMSF -418	ICAMSF -437	ICAMSF -455	ICAMSF -474	ICAMSF -497
12:10PM-12:30PM	**Invited Talk 3** Dr. Avinash Kumar IITDM Kancheepuram	**Invited Talk 4** Dr. Jadab Sharma PU Chandigarh	12:10PM-12:20PM	ICAMSF -351	ICAMSF -362	ICAMSF -381	ICAMSF -401	ICAMSF -419	ICAMSF -438	ICAMSF -457	ICAMSF -477	ICAMSF -498
			12:20PM-12:30PM	ICAMSF -353	ICAMSF -364	ICAMSF -383	ICAMSF -404	ICAMSF -420	ICAMSF -439	ICAMSF -459	ICAMSF -478	ICAMSF -499
12:30PM-12:40PM	**Invited Talk 5** Dr Srihari Dodla, IIT BHU	**Invited Talk 6** Dr. Anuj Sharma, CAS-AKTU Lucknow	12:30PM-12:40PM	ICAMSF -354	ICAMSF -367	ICAMSF -384	ICAMSF -406	ICAMSF -421	ICAMSF -440	ICAMSF -461	ICAMSF -480	ICAMSF -500
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1:30PM-2:30PM	**LUNCH**											
Time	**S36 Session Chair: AKS & GJ**	**S37 Session Chair: MKS & AS**	**Time**	**S38 Session Chair: FZ**	**S39 Session Chair: MIUH**							
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2:40PM-2:50PM	ICAMSF-460	ICAMSF-491	2:40PM-2:50PM	ICAMSF-510	ICAMSF-515							
2:50PM-3:00PM	ICAMSF-475	ICAMSF-495	2:50PM-3:00PM	ICAMSF-511	ICAMSF-516							
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3:30PM-4:00PM		**VALEDICTORY AND FEEDBACK SESSION**										

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LN	Dr. Leeladhar Nagdeve, National Institute of Technology Delhi	S2
MKS	Dr. Manvendra Kumar Singh, Grpahic Era University	S2, S37
RK	Dr. Rajesh Kumar, NIT Kurushetra	S3
GJ	Dr. Gopal Ji, Graphic Era University, Dehradun	S3, S36
AS	Dr. Anoop Shukla, Amity University, Dehradun	S4, S37
NGN	Dr Nikhil G N, National Institute of Technology Jalandhar	S5
AKS	Dr. Arun Kumar Singh, Visvesvaraya National Institute of Technology Nagpur	S6, S36
SP	Dr. Sanjhi Paliwal, CRIO, Chitkara University, Punjab	S7
TVKG	Dr. TVK Gupta, Visvesvaraya National Institute of Technology Nagpur	S8, S25
CC	Dr. Chingakham Chinglenthoiba, CRIO, Chitkara University, Punjab	S9
TVVLNR	Prof. TVVLN Rao, Assam downtown University, Guwahati	S10
VKP	Dr. Vinay Kumar Pandey, Manav Rachna International Institute of Research and Study, Gurugram	S12, S28
AK	Dr. Asheesh Kumar, CSIR-Indian Institute of Petroleum, Dehradun	S13
SS	Dr. Seema Singh, CRIO, Chitkara University, Punjab	S13
JK	Dr. Jimmy Karloopia, Punjab Engineering College (Deemed to be University), Chandigarh	S14
SV	Dr. SAJITH V, National Institute of Technology Calicut	S14
RKS	Dr. Ranjeet Kumar Sahu, National Institute of Technology Karnataka (NITK) Surathkal	S15, S26
PCV	Dr. Piyush Chandra Verma, BITS Pilani Hyderabad	S11, S26
RS	Dr. Rajesh Shukla, Thapar University, Patiala	S17
AR	Dr. Ankush Raina, Shri Mata Vaishno Devi University, Katra, J&K	S18
HK	Dr. Harish Kumar, National Institute of Technology Delhi	S19

AKS	Dr. Anuj Kumar Sharma, Centre for Advanced Studies AKTU Lucknow	S20, S25
AK	Dr. Avinash Kumar, Indian Institute of Information Technology Design and Manufacturing Kancheepuram, Chennai	S21
SHD	Dr Srihari Dodla, IIT, BHU, Varanasi, UP	S22
MIUH	Dr. Mir Ifran Ul Haq, Sri Mata Vaishno Devi Katra, Jammu and Kashmir	S23, S39
NS	Dr. Nikhil Shrivastav, CRIO, Chitkara University, Punjab	S27
BS	Dr. Bhisham Sharma, CRIO, Chitkara University, Punjab	S29
RT	Dr. Renu Thakur, CRIO, Chitkara University, Punjab	S30
DG	Dr. Deepam Goyal, CURIN, Chitkara University, Punjab	S31
VS	Dr. Vandana Sharma, CURIN, Chitkara University, Punjab	S32
SM	Dr. Sanjay Mohan, Sri Mata Vaishno Devi Katra, Jammu and Kashmir	S33
AM	Dr. Arpit Mehrotra, Chitkara School of Health Sciences, Chitkara University, Punjab	S34
AA	Prof. Ankush Anand, Sri Mata Vaishno Devi Katra, Jammu and Kashmir	S35
FZ	Dr. Falak Zahoor, National Institute of Technology Srinagar	S38
MFUH	Dr. Mir Faizan Ul Haq, Indian Institute of Technology, Jammu	S16
SJ	Dr. Sagar Juneja, Chitkara University, Punjab	S23

GOOGLE MEET LINK

(Created By JKK) S1, S4, S15, S24, S27, S38: https://meet.google.com/oxi-kmpj-vzz
(Created By JKK) S5, S16, S28, S39: https://meet.google.com/ohn-kxsf-reh
(Created By JKK) S6, S17, S29: https://meet.google.com/hmq-utds-ebn
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(Created By SS) S9, S20, S32: https://meet.google.com/dvd-dhnv-eck
(Created By SS) S10, S21, S33: https://meet.google.com/xme-ikpm-vnd
(Created By SP) S11, S22, S34: https://meet.google.com/vtp-dfsc-yis
(Created By SP) S12, S23, S35: https://meet.google.com/bmu-pusx-nst

Rooms for the offline Session

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ICAMSF-001

Advancements in Surface Design and Adaptive Lubrication for Enhanced Tribological Performance in Spur Gears

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This study explores advancements in surface design and adaptive lubrication strategies aimed at improving the friction and wear performance of spur gears. A key focus is the influence of surface roughness parameters—specifically skewness (Ssk) and kurtosis (Sku)—along with micro-elastohydrodynamic lubrication (Micro-EHL) on wear mechanisms such as micro pitting and pitting failures. To quantify wear severity and optimize surface texturing, advanced analytical techniques, including ferrous particle size distribution analysis and principal component analysis (PCA), are employed. PCA effectively reduces dimensionality, enabling the identification of critical surface parameters that impact gear wear and lubrication behavior. Statistical indicators further assess asperity distribution on worn surfaces, offering deeper insights into surface topography and its effect on tribological performance.

The study integrates experimental investigations, theoretical modeling, and real-time monitoring to evaluate spur gear tribology under various operating conditions. Given that micropitting can progress into macro-pitting, spalling, and eventual tooth fractures, predictive models are reviewed to assess micro-pitting initiation and propagation. These models incorporate key tribological parameters, including contact pressure distribution, sliding and rolling velocities, lubricant film thickness, and shear stresses during meshing. Additional factors such as gear misalignment, lubricant degradation, wear debris formation, and surface texturing are analyzed to guide lubricant formulation optimization, with an emphasis on additive-enhanced lubrication efficiency and gear longevity.

Experimental findings highlight the effectiveness of 2D nanoparticles—including hexagonal boron nitride (h-BN), reduced graphene oxide (rGO), and molybdenum disulfide (MoS_2)—as lubricating additives. These nanoparticles enhance lubrication performance by stabilizing the lubricant film, reducing friction, and minimizing wear. Moreover, the study discusses the role of ultra-thin lubrication layers inspired by nanolubrication concepts, which have demonstrated significant potential in improving surface protection, operational stability, and longevity. Overall, this research underscores the importance of integrating surface engineering, lubricant optimization, and real-time condition monitoring to enhance spur gear durability and efficiency. The findings provide a foundation for advanced tribological design strategies, ensuring improved gear performance in industrial applications. Future research directions include refining multi-scale surface texturing techniques and developing intelligent lubrication systems for enhanced predictive maintenance and system reliability.

Keywords: Tribology, Gear, Lubrication, Surface Topography

ICAMSF-002

An evaluation of desulfurization technologies for sulfur removal from liquid fuels

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Sulfur compounds signify one of the most prevalent impurities found in the crude oil. Sulfur in liquid fuel oil leads directly to the sulfate particulate matter (SPM) and emission of SO_2 pose a threat to community property and public health; and decreases the engine life due to corrosion. Additionally, the sulfur compounds in the exhaust gases of diesel engines can meaningfully damage the emission control technology intended to meet SPM and NO_x emission standards. The research efforts for developing conventional hydrodesulfurization and alternative desulfurization methods such as selective adsorption, biodesulfurization, oxidation/extraction (oxidative desulfurization), etc. for removing these refractory sulfur compounds from petroleum products are on the rise. Research laboratories and refineries are spending huge amounts of money in finding a viable and feasible solution to reduce sulfur to a concentration of less than 10 mg L^{-1}. This paper reviews the current status in detail of various desulphurization techniques being studied worldwide. It presents an overview of novel emerging technologies for ultra-deep desulfurization so as to produce ultra-low sulfur fuels.

Keywords: Direct desulfurization (DDS), Cyclohexylbenzene (CHB), Coordinately unsaturated sites (CUS), Diphenylsulfide (DPS)

ICAMSF-003

Electroless Ni-P Based Micro-Nanocoating Technology for automotive and defence applications

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High-strength marine-grade AH 36 steel is used to fabricate ship structures and components such as waterjet suction pipes, strainers, and seawater pump intake ducts for propulsion and various auxiliaries' equipment, as these components are subjected to cyclic loading from rough seas and high wind forces, as well as erosive and corrosive degradation from the harsh marine environment. This research aims to design and synthesise the optimal ENi-P-nano TiO_2 coating synthesised with Zwitterionic surfactant (C14-SB) on AH36 steel due to its unique characteristics. The present work begins with the optimal coating formulation by identifying the best composition of input process parameters such as bath temperature, bath pH, weight addition of Zwitterionic surfactant, and nano TiO_2 particles to achieve higher microhardness in the coated surface, employing a Taguchi-based Design of experimental design. Subsequently, to study the resistance of ENi-P-nano TiO_2 coated surface against the jet impingement combined with AFS 50/70 quartz sand to recreate the marine environment to identify the optimal design of input factors composition. In addition to identifying the significant factors contributing to higher resistance in the coated surface, the study aimed to examine the substrate's contribution to enhancing mechanical properties in the coatings. Hence, the composite modified resilience (CMR) value was deduced for the correlation and subsequent comparison of all coated surfaces with the weight reduction. The experimental study also indented to identify the significant input factors, and the contribution of compositional elements like Phosphorous, Nickel, and TiO_2 was discussed to achieve superior resistance against the jet impact.

Finally, from the corrosion studies between the ENi-P-nano TiO_2 coatings, the added C14-SB surfactant contributed highly to the equal dispersion of Titanium particles in the Ni-P matrix, resulting in minimal porosity in the optimal ENi-P-nano TiO_2 coated surface. Accordingly, the optimal ENi-P-nano TiO_2

coating has shown a 97.26% corrosion rate reduction than the base metal. These findings illustrate the importance of input parameters in the electroless coating, the significant contribution of C14-SB surfactant and nano TiO_2 in the fabricated ENi-P-nano TiO_2 coatings for the enhanced mechanical, nanomechanical, and electrochemistry characteristics of the ENi-P-nano TiO_2 coatings. Further, this study indicates that the electroless-based Ni-P-nano TiO_2 coatings can be used on naval grade AH36 steel, and its positive outcome has shown its compatibility with marine applications.

Keywords: Coating, Corrosion, Alloy Steel

ICAMSF-004

Numerical and experimental investigations of pro-eutectic and eutectic phases in two-phase composites

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The single/polycrystal has great applications in manufacturing aerospace, electrical and electronic components. This study presents numerical multiscale modeling involving two different length scales that predict the deformation behavior in the absence of physical experiments. Copper-based composites can produce high mechanical strength and sufficient electrical conductivity. In addition, they offer the potential to provide nanostructured composites by casting and metal forming. The eutectic composites are studied using the elasto-viscoplastic material model by Dodla et al. The developed eutectic model has been extended for the hypo-eutectic composites, considering the effects of solid solution particles and the lamellar regions. In this work, we study the near-eutectic copper-based composites to capture the pro-eutectic and the eutectic morphology and to determine the deformation behaviour and the microstructure evolution. In the case of near eutectic composite, alternate layers of lamellae and the pro-eutectic regions of Cu-rich phase are present. The lamellae's orientation, the lamellar's thickness, and the phase boundaries' structure are responsible for the mechanical properties of the copper-based composites. The developed model has been validated with experimental investigations.

Keywords: Composites, Numerical Analysis, Eutectic Phases

ICAMSF-005

Microwave-induced plasma drilling of polymer composites

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Microwave-induced plasma (MIP) drilling is emerging as a novel technique for machining polymer composites, offering advantages such as reduced tool wear, minimal heat-affected zones, and enhanced precision. This talk explores the fundamental principles of MIP drilling, its mechanisms, and its impact on composite integrity. Key advancements, challenges, and potential industrial applications will be discussed, highlighting its role in next-generation composite manufacturing for aerospace, automotive, and other high-performance sectors.

Keywords: Drilling, Microwave, Tool Wear

ICAMSF-006

Walkway of Innovation in the field of Advanced Manufacturing and its role in creating a better tomorrow with solutions for Industries

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The conventional manufacturing processes have been met the requirements of the industry over the past decades. However, to become successful in today's manufacturing industry, the industry has to meet the various demands raising in the market, in particular, the demands for innovative design and manufacture of high quality near shape products with less cost, increased productivity and more reduction in wastage of material, exotic materials processing, novel materials and products. But the conventional manufacturing techniques could not meet the above demands. The industrial researchers have made continuous effort to advance the manufacturing technology. So, advanced manufacturing processes are eventually emerged as efficient manufacturing processes to meet the shortcomings of the conventional manufacturing techniques.

In today's competitive industries, the stringent designers' requirements for the products with higher and economic production rate, and better quality were imparting much more pressure on the capabilities of conventional machining techniques to achieve the same. Also, many problems have also imposed during the machining of new exotic materials such as super alloys, carbides, ceramics, etc. with ever-increasing mechanical properties by conventional means. Therefore, to meet these challenges, advanced machining processes that are classified under the advanced manufacturing processes has developed and established in the industry as efficient and economic alternatives to conventional machining ones. Additionally, these advanced manufacturing processes have become significant for complexity of workpiece surface shape and size, surface integrity and miniaturization requirements. Modern manufacturing processes have been used for machining of miniature features on various engineering materials using precise controlled energy sources. These features are obtained by removing tiny bit of materials in the form of debris or chips at micro/nano level. So far, exploration on the production of these features- micro holes, channels, and debris as nanomaterials (byproduct) at a single stretch using a single energy source and their applications in the promising fields has not been addressed. This has become a challenging issue.

The advanced micromachining processes have found widespread applications in many industrial domains for making miniature features like micro holes and channels. The micro holes are machined in fuel injection automotive nozzles, filters for food processing and textile industries, cooling holes in aircraft turbine blades, spinneret holes for synthetic fibers, catheters, needles and other medical device components, etc. The micro channels are created in nuclear reactors, MEMS devices, micro fluidic devices, etc. Moreover, in recent times, smart nanomaterials have gained significant attention in recent times and show a great promise for providing us many breakthroughs in the near future that will change the direction of technological advances in a wide range of applications. Indicatively, such applications include self-healing materials for coating application in automobiles, damping in automobiles, flexible electronics, drug delivery applications, implants and prostheses, energy generation and conservation, smart textiles, catalysis, optical fields and so on. The smart nanomaterials (SNMs) are the stimuli-responsive nanomaterials that can react to the varying environmental conditions like variation in temperature, mechanical loads, light, pH-value, moisture, electrical charge, and magnetic fields. SNMs

can exhibit their own functions according to these variations. This indicates that these materials can change their excellent physical, mechanical, thermal, electrical, permeable, catalytic, optical properties, etc. in an intelligent way for adapting to the surrounding environment. A few methods have been developed for the synthesis of SNMs of required size and shape. These methods include sol-gel, solution precipitation, hydration-ultrasonic dispersion, sputtering, track-etching and micro-emulsion. But, from the methods mentioned above, some of them are normally hard to control the nanostructured materials size and distribution, and their subsequent aggregation. Further, most of these methods exhibit low production rates and high cost. Therefore, there is a recognized need for, and it would be most advantageous to have a simple, compact, versatile, and cost-effective method for producing SNMs at high yield with respect to known methods. This feature calls for a spark ablation based digital nano-manufacturing method for the production and characterization of SNMs, which has not been explored, and finally to study the application suitability of these materials in the scientific, medical and industrial society.

Keywords: Advanced manufacturing, Nanomaterials,

ICAMSF-007

Exploring Mechanical and Tribological Behaviour of Additive Manufactured Polymers

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Additive Manufacturing has evolved as an alternative manufacturing process however the technology being in nascent stages particularly with regard to standardization. The talk will focus on the role of standardization in the AM sector to facilitate reliability, and quality control. Further, the talk will focus on sharing various insights related to various mechanical tests like bending, tensile, impact testing of polymeric parts. Also results related to studying friction and wear behaviour of various polymeric materials and the role various AM technologies can play in improving the tribological properties. Also, insights related to various characterizations carried out related to study the worn surface morphology and various fracture modes. As AM offers flexibility in developing surfaces of complex geometries, the talk shall also delve into various aspects of surface engineering and Additive Manufacturing.

Keywords: Additive Manufacturing; Polymers; Tribology; SEM

ICAMSF-008

Synthesis of Innovative Electrodes for Electrochemical Treatment of Wastewater

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The choice of electrode material is of paramount importance as it affects the selectivity and the efficiency of the electrochemical process. Also, the performance of electrochemical methods depends on the electrode material. In other words, the anode materials play a crucial role in the electrode due to their ability to control the oxidation of contaminants. With good chemical resistance and high efficiency in the treatment of wastewater, different anodes can be used such as Ti-supported metal and metal oxide like Pt, RuO_2- TiO_2 and TaO_2-IrO_2, graphite, etc. The requirements that electrode materials need to meet include

high selective adsorption, long-term stability in the operating environment, good mechanical qualities, affordability, and safeguarding the environment. Moreover, in the electrochemical conversion of organic contaminants, a desirable electrode should have a high oxygen evolution potential (OEP), high reliability, and good electro-catalytic activity.

Numerous electrode materials presented in research articles may lack practical applicability in real-world projects, indicating a need for a more exhaustive examination of a specific number of electrode materials employed for potential or actual applications. In the past, EO treatment with TiO_2 as the base electrode has been suggested as a practical approach due to affordability, non-toxicity, stability, and strong oxidizing power. There has been a lot of discussion about combining TiO_2 with carbon-based materials such as expanded graphene (G), graphene oxide (GO), and carbon nanotubes. Among these, there has been great interest in improving the EO capability of TiO_2 against contaminants by adding graphene and carbon nanotubes. Many studies are being conducted on surface modifications of TiO_2 with carbonaceous material and their application as electroactive electrodes. Due to their chemical and thermal stability, pore structure, and high conductivity, carbonaceous nanoparticles are excellent electrocatalytic materials. Metal– carbon/ TiO_2 composite can be used to improve the EO performance and the effective e-- h+ separation properties of noble metals.

Among various metallic species grown on TiO_2 surfaces, SnO_2 has a unique e--h+ dissociation and significant interfacial charge transfer ability. Therefore, it is a promising prospect to produce graphene and SnO_2-based materials for electrocatalytic treatment. Accordingly, the authors consider that combining TiO_2, GO, and SnO_2 may be a potentially successful way to produce outstanding light absorbability, electron transferability, and chemical stability.

In the present study, the Ti/TiO_2-GO-SnO_2 electrode was synthesized using an anodic oxidation and characterized by various techniques.

Water pollution by recalcitrant compounds is a growing concern due to the continuous introduction of new chemicals into the environment. Choosing appropriate measures and developing successful strategies for eliminating hazardous wastewater contaminants from industrial processes is currently a primary goal. Electroplating wastewater contains toxic pollutants such as cyanide (CN), heavy metals, oils, greases, organic solvents, BOD, COD, and solids, making it highly toxic and corrosive. These contaminants pose severe health risks, including cancer, necrosis, and organ damage, necessitating effective treatment before discharge. Advanced oxidation processes (AOPs), particularly electrochemical treatments, have emerged as promising methods for removing organic and inorganic pollutants. The electrochemical treatment process has several advantages over traditional technologies, including complete removal of persistent organic pollutants, environmental friendliness, ease of integration with other conventional technologies, less sludge production, high separation, and shorter residence time.

The electroplating wastewater treatment was done by the electro-oxidation (EO) method through a new Ti/TiO_2-GO-SnO_2 electrode in a once-through continuous mode. Response Surface Methodology (RSM) was utilized to optimize pH, current density and time for removal of electroplating effluents and energy consumption. The effect of reactive species scavengers on removing electroplating effluents has been studied. The kinetics and cost analysis were also carried out under optimal conditions. Once-through continuous experiments were carried out at different flow rates to determine the viability of the process at industrial or pilot scale applications. The synthesized electrode proved highly reusable, maintaining durability even after sixty cycles of usage. The observed results confirm that the EO with Ti/TiO_2-GO-SnO_2 electrode is low-cost and effective for removing electroplating effluents.

Keywords: Electrode synthesis, Electrochemical oxidation (EO), Electroplating wastewater, Ti/TiO_2-GO-SnO_2 electrode.

ICAMSF-009

Artificial Intelligence for a Sustainable Future

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This talk will explore the transformative role of artificial intelligence (AI) in advancing materials science for a sustainable future. By harnessing the power of AI, we can expedite the discovery and optimization of materials that are crucial for clean energy, energy storage, sustainable construction, and recycling—key pillars in addressing global environmental and sustainability challenges. Through case studies, we will examine how AI is enhancing the performance of critical materials like solar cells, batteries, and green building materials. Additionally, the talk will emphasize the need to strengthen AI's foundations, focusing on data infrastructure, talent development, and green computing, to ensure that AI can effectively support and accelerate global sustainability initiatives.

Keywords: Artificial Intelligence, Sustainability, Environment

ICAMSF-010

An Innovative Step Towards Decarbonization: Hydrate-Based CO2 Capture and Sequestration

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The increasing level of CO_2 emissions is the primary driving force for global warming, resulting in climate change. In the year 2022, the global CO_2 emission was about 37 Gt, which is projected to increase by 1% in 2023. To prevent the warming to nearby 1.5 °C, global CO_2 emission inevitabilities to be turned down by 43% by 2030. India established the objectives of reducing CO_2 emissions to 50% by 2050 and net zero by 2070. Carbon Capture, Utilization, and Storage (CCUS) is the key step to achieving these targets. CCUS involves the capture of CO_2 from large point sources (e.g., thermal power plants, steel, cement, or other industrial plants), the captured CO_2 can be converted to generate value-added products (e.g., methanol, ethanol, polymers, etc.). It appears a very attractive approach; however, the current CO_2 utilization technologies are not sufficient to control the substantial gigatonnes of CO_2. Therefore, permanent deep geological storage would be a potential large-scale option wherein the captured CO_2 can be compressed, transported (via pipeline/ship), and injected into depleted oil and gas reservoirs, saline aquifers, basalts, and oceanic/subsea storage. The estimated CO_2 storage capacity for India is ranging from 395 to 614 Gt CO_2. Gas hydrate-based CO_2 capture and sequestration is one of the innovative technologies that has gained significant attraction due to its high storage capacity (One tonne of CO_2 can be stored in ~3.5 m3 of gas hydrate) and stability in subsea sediments.

Keywords: Global Warming, CO_2, Decarbonization

ICAMSF-011

Modeling healing mechanisms in sustainable pavement materials

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With growing emphasis on sustainability and the urgent need to extend the lifespan of transportation infrastructure, innovative strategies in pavement design have become paramount. This keynote address introduces a mechanistic approach to understanding and modeling the healing behavior of asphalt binder systems, a critical component in the development of greener, sustainable, and more resilient pavements. In this work, healing behavior of asphalt binder systems is modeled while accounting for nonlinearity and thixotropy. Grounded in the Simplified Viscoelastic Continuum Damage (S-VECD) framework, this work elucidates how intrinsic healing mechanisms can mitigate progressive damage in binder materials, thereby extending pavement service life and reducing the environmental footprint. In particular, the impact of recycling agents is highlighted. Further, healing master curve formulations are developed, providing a predictive framework that supports optimized material selection and sustainable pavement design.

Keywords: Materials, Sustainability, Modeling

ICAMSF-012

Unveiling the Electrocatalytic Attributes of M5X4Tx MXenes in Catalysing Hydrogen Evolution Reactions

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In this talk, I will discuss the the electrochemical properties of M5X4 MXenes, focusing on their effectiveness as electrocatalysts for the hydrogen evolution reaction (HER). Ion exchange was employed for the first time to systematically modulate the structure of M5X4 MXenes, providing new insights into the relationship between interlayer spacing and HER performance. Our results demonstrate that the TMA intercalated Mo4VC4 (TMA-Mo4VC4) exhibits outstanding electrocatalytic performance, achieving the lowest recorded areal overpotential of 172 mV and a gravimetric overpotential of 90 mV for Mo-based MXenes in HER studies. In contrast, (TiNb)5C4 and (TiTa)5C4 show higher overpotentials, making them more suitable for supercapacitor applications due to their wider capacitive window. Li-ion exchange increases the areal and gravimetric overpotentials of Mo-based MXenes to 212 mV and 131 mV, respectively, as reduced interlayer spacing restricts access to active Mo sites. Long-term chronoamperometric studies confirm the electrochemical stability of Mo-based MXenes for HER, further supported by post-HER XPS analysis. This work highlights the critical influence of interlayer engineering on electrocatalytic efficiency and establishes TMA-Mo4VC4 as a promising catalyst for sustainable hydrogen production.

Keyword: High-ordered MXene, HER, Water Splitting, Engineering

ICAMSF-013

Microplastic distribution in surface and groundwater bodies: A source apportionment approach

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Microplastics are emerging contaminants, that are ubiquitous in every environmental compartment and pose adverse impacts to the environment. The anthropogenic activities are some of the major influential factors contributing to its abundance in the environment. Of the various activities, unscientific solid waste dumps are among the most predominant contributory factor of microplastic abundance in groundwater systems. In surface water, especially in estuarine environments, cage farming using plastic fishing nets contribute to the abundant microplastic concentration. The present talk mainly focuses on two aspects:

1. How the unscientific solid waste dumping practices lead to the microplastic abundance in groundwater of Kollam corporation
2. How cage farm nets undergo photodegradation and release microplastics into estuarine environment

The talk will cover the following topics:

1. Microplastics – an introduction
2. Microplastics distribution in groundwater near solid waste dumps of Kollam corporation
3. Analysis of influence of distance and area of solid waste dumps on the microplastic characteristics
4. Photodegradation of nylon, polyester and High-Density Polyethylene cage farm nets studies
5. Analysis of degradation rate of cage farm nets
6. Identification of optimized polymer for cage net using Fuzzy AHP TOPSIS analysis
7. Microplastic abundance at locations of cage nets in the Ashtamudi estuary
8. Recommendations for a sustainable biopolymer-based cage net

ICAMSF-014

Biochar-enhanced Carbon Sink and Environment Remediation from Campus Bio-wastes

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The major aim of this study would be to upcycle campus bio-waste of National Taiwan University into biochar and its application in different regions while considering the circular economy (CE). At present, almost every sector produces huge quantities of bio-wastes and then strives to cope with its disposal costs. So, it is quite essential to introduce the CE based management systems. The major tasks include: production of biochar from campus bio-wastes, biochar-enhanced carbon sequestration, biochar application in wetlands and soils, recycled CO_2 nanobubble utization, and biochar utization in wastewater treatment and reclamation. A circular bio-economy can be established by using wastes from campus, experimental farm and experimental forest to biochar, with the by- products going into use in different fields like soil, air, water and wetlands at NTU. This CE application minimizes waste through numerous processes and approaches, hence enhancing its value. It demonstrates an open door for the progress of a CE by addressing the use of wastes using an innovative mixture of techniques and advantageous interlinked strategic approaches. This project plan will be crucial in laying a conceptual groundwork and

enhancing the commercialization of CE-based environmental management using biochar on the field scale.

ICAMSF-015

Sustainable Metal Additive Manufacturing in Dental Applications

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Additive manufacturing (AM) has transformed the dental industry by enabling the production of high-precision, patient-specific prosthetics and implants using advanced metal materials such as titanium (Ti), cobalt-chromium (Co-Cr), nickel-chromium alloys and stainless steel. While AM enhances material efficiency and design flexibility, sustainability challenges arise from metal powder consumption, energy-intensive processes, and waste generation. By adopting circular economy principles, such as closed-loop recycling and responsible material sourcing, AM can significantly reduce environmental impact. These efforts align with the United Nations Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and Well-being) by ensuring safe, biocompatible, and accessible dental solutions. SDG 9 (Industry, Innovation, and Infrastructure) through advancements in eco-friendly manufacturing. SDG 12 (Responsible Consumption and Production) by promoting resource efficiency and SDG 13 (Climate Action) by reducing the carbon footprint of metal AM through energy-efficient processes and sustainable material sourcing. Integrating sustainability into metal-based AM not only enhances environmental responsibility but also fosters long-term innovation in the dental industry. This study explores sustainable strategies in metal additive manufacturing with a focus on recycling and reusing metal powders commonly used in dental applications, such as nickel-chromium, cobalt-chromium and titanium alloys. The challenges of powder degradation, contamination, and energy consumption in the recycling process are discussed alongside innovative solutions. By enhancing material efficiency and reducing waste, sustainable practices in dental AM can contribute to a more circular economy, minimizing environmental footprint while maintaining high-performance standards for dental restorations and prosthetics.

Keywords: dental additive manufacturing, sustainability, powder recycling, powder reuse

ICAMSF-016

Automated High-Throughput Analysis and Fundamental Insights into CO2 Solubility in Ionic Liquids

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Addressing rising CO_2 emissions is a critical global challenge, necessitating efficient capture technologies. Room-temperature ionic liquids (RTILs) have emerged as promising solvents for CO_2 capture due to their tunable properties. Traditional capture methods operate at high pressures, increasing costs and limiting scalability. To overcome this, an automated high- throughput electrochemical system using a 96-well microtiter plate has been developed for rapid and accurate CO_2 solubility measurements in RTILs, requiring only microliter volumes. Cyclic voltammetry (CV), combined with a high-throughput three-electrode setup, enables direct assessment of CO_2 permeance and Henry's constant via Cottrell

analysis. Results reveal that Henry's constant correlates with void fraction and electrostatic interactions, exhibiting a first-order dependence on void fraction and a second-order dependence on ion pairing strength, with a synergistic effect between the two. As void fraction increases or electrostatic interaction decreases, Henry's constant declines, but for RTILs with lower void fractions, an initial increase in Henry's constant is observed before a subsequent drop with rising electrostatic interaction. This study underscores the efficacy of high-throughput CV for CO_2 solubility determination and highlights void fraction and electrostatic interaction as key design parameters for novel RTILs.

Keywords: Room Temperature Ionic Liquids (RTILs); High-Throughput; Electrochemical Measurement; CO_2 Solubility; Void Fraction.

ICAMSF-017

Post-Processing of the Additively Manufactured Biomedical Implants through Hybrid Electrochemical Magnetorheological Finishing Process

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Additive Manufacturing (AM) or 3D printing provides the benefits of individualizing the implant per patient requirements. However, the poor surface quality of additively manufactured components is a major limitation as it increases its wear rate on their tribological interaction. The higher wear rate increases the generation of debris particles, spread inside the human body through blood circulation, responsible for the systematic toxicity of various organs, including kidneys, eyes, levers, etc. Therefore, the present work proposed a novel post-processing method to improve the surface quality of additively manufactured alloys. Hybrid Electrochemical Assisted Magnetorheological (H-ECMR) utilizes the synergic action of mechanical abrasion and electrochemical reaction to enhance the surface quality of the parts without affecting their surface topography. The electrochemical reaction forms a uniform and thick oxide layer on the Ti-6Al-4V surface as layer thickness increases to 78 nm from its initial value of 8 nm, further improving its corrosion resistance. The present work details the working principle of the H-ECMR finishing process with an analysis of the impact of process parameters on the reduction in surface roughness.

Keywords: Additive Manufacturing, Magnetorheological Finishing, Biomedical

ICAMSF-018

Development of Solid-State Electrolyte Materials for Next-Generation Lithium/ Sodium- Ion Batteries

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The increasing demand for efficient and safer energy storage solutions has driven the development of solid-state electrolytes (SSEs) as a transformative alternative to conventional liquid electrolytes in rechargeable lithium-ion batteries (LIBs) / sodium ion batteries (SIBs). Traditional liquid electrolytes based on $LiPF_6$ dissolved in organic solvents shows safety concerns and limiting the performance of these

battery systems, especially in LIBs for high-energy-density applications such as electric vehicles (EVs) and grid storage. Solid-state electrolytes, on the other hand, offer multiple advantages such as non-flammability, wide electrochemical potential stability windows, and high mechanical strength, facilitating the use of high-capacity lithium-metal anodes and high-voltage cathodes for next-generation rechargeable battery systems. However, despite these advantages, the widespread commercialization of SSEs faces critical challenges, including low ionic conductivity compared to liquid electrolyte, poor electrode-electrolyte interfacial contact, and mechanical brittleness. This talk will present a comprehensive overview of recent development in SSE materials, including inorganic oxides, sulfides and polymer-based electrolytes, along with their potential for enabling high-performance, safe, and sustainable electrolytic materials for rechargeable batteries: lithium-ion/ sodium-ion batteries. In particular, oxide-based electrolytes, such as garnet-type Li7La3Zr2O12 (LLZO) and NASICON-type structures, have emerged as promising candidates due to their high lithium-ion conductivity, excellent chemical stability, and compatibility with lithium-metal anodes. The talk will highlight key strategies for enhancing the electrochemical performance of these materials, including aliovalent doping, grain boundary engineering, and ion beam implantation, which play a crucial role in improving ionic transport and stabilizing the solid-electrolyte interface. Additionally, oxide/phosphate-based ceramic electrolytes, known for their high ionic conductivity and processability, will be discussed, along with challenges such as moisture sensitivity and interfacial degradation. The integration of SSEs into full-cell configurations, including all-solid-state batteries (ASSBs), poses additional challenges related to processing, scalability, and cycling stability. Hence, the overview of the SSEs will highlight the pathway toward realizing commercial viability for all-solid-state lithium-ion batteries with superior energy density, long cycle life, and enhanced safety.

Keywords: Lithium-ion Batteries, Solid state electrolyte, LLZO, Electrochemical

ICAMSF-019

Machining with nanoparticle enriched cutting fluids: Technology, Research Gaps and way forwards

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In any metal cutting operation, the cutting fluid plays a vital role by cooling the surface of the work piece and the cutting tool, removing chips from the cutting zone and by lubricating the tool-work piece interface. However, misuse of the cutting fluid and wrong methods of its disposal can affect human health and the environment badly. Also, it accounts for 16 - 20% of the total cost of manufacturing in the production industry. Among various techniques available on application of the coolant, researchers, of late, have been focussing on MQL/NDM as it minimizes the use of coolant. The Minimum Quantity Lubrication (MQL) technique has proved to be suitable because it complies with the requirements of 'green' machining. This work focusses on the technology involved in nanoparticle enriched cutting fluids in machining. Furthermore, the present work also discusses its effect on the performance parameters of different machining processes. Most of the experimental studies have shown that application of nanofluids with MQL reduces surface roughness better than dry machining and similar to that as produced under wet machining. Its application also reduces cutting forces, cutting zone temperature, tool wear, friction coefficient in comparison to dry and wet machining. Therefore, use of nanofluids with

MQL in machining of metals has proved to be a viable alternative to the flood lubrication under similar performance parameters. The work also discusses the research gaps for future investigations.
Keywords: MQL, Machining, Nanoparticles

ICAMSF-020

Encapsulated phase change material-based cooling for batteries/electronics

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Thermal management of electronic devices and batteries is one of the most significant concerns confronting the world today, as it is critical for the proper operation of both electronics and batteries. Various cooling techniques employed for the thermal management of batteries/electronics include air-cooling systems, liquid-cooling systems, phase change materials (PCM)-based cooling, etc., with each of them having its pros and cons. The use of phase change material (PCM) is an attractive option for the thermal management of electronics & batteries, due to its inherent advantages such as high latent heat of fusion and high specific heat. Encapsulated phase change material-based cooling for batteries and electronics is a thermal management technique where tiny capsules containing a phase change material are integrated into the system, allowing it to absorb and release large amounts of heat, at a relatively constant temperature during the phase transition. This talk will explore the application of encapsulated phase change materials for the cooling of electronics and battery packs. Graphene-incorporated polystyrene encapsulated composite PCM (GnePCM) based nanofluids has been demonstrated as an excellent coolant for the thermal management of battery packs. The talk will further highlight some of the recent efforts in the development of flexible heat spreaders with the incorporation of encapsulated phase change materials, with a focus on the real-life applications.
Keywords: Phase Change Material (PCM), Polystyrene Encapsulated Composites, Liquid-Cooling Systems.

ICAMSF-021

Advanced Nanomaterials for Environmental Sustainability: Solving Water and Energy Challenges

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Water contamination and energy shortages are two critical challenges threatening sustainable development. Industrial activities, particularly in the textile, pharmaceutical, and chemical sectors, release wastewater containing persistent organic pollutants such as alkanes, aromatics, surfactants, pesticides, and dyes. These toxic compounds degrade slowly and pose significant environmental and health risks. Meanwhile, the rising global energy demand, projected to increase by over 33% by 2035, remains heavily dependent on fossil fuels, further exacerbating environmental concerns. Addressing these intertwined issues requires innovative solutions that integrate advanced materials and sustainable energy strategies. This presentation explores the potential of advanced oxidation processes (AOPs) and photocatalytic nanomaterials, such as Fe-doped TiO_2, $Zn_{0.5}Cd_{0.5}S/MoS_2$ composites, and zeolitic imidazole frameworks

(ZIF)-8/red phosphorus, for wastewater treatment and hydrogen production. By harnessing solar energy and nanotechnology, these materials enable efficient organic pollutant degradation and H_2 generation, paving the way for self-sustaining, scalable water treatment systems that contribute to a cleaner and greener future.

Keywords: Advanced Oxidation Processes (AOPs), Zeolitic Imidazole Frameworks, Hydrogen Production, Scalable Water Treatment.

ICAMSF-022

Laser modified surfaces and its applications in wear and biotribology

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A surface plays an important role in Mass, Energy and Momentum transfer, as in general two or more bodies interact with each other through surfaces mainly. Hence, a modified surface plays an important role. This talk will focus on the design, mechanism and application of modified surfaces. Surface modification is consisting of chemical and physical modification. We have done these modifications using a Nano-second Pulsed Fiber Laser. At the end we will discuss the application of these surface in friction reduction, wear and bio-tribology.

Keywords: Biotribology, Friction, Pulsed Fiber Laser

ICAMSF-023

Metal Additive Manufacturing Process Using Laser Cladding

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Laser cladding is a metal deposition process used for fabrication/repair components made from hard to cut materials/alloys of high value. As it is a metal deposition process, this can initiate a new area of research for metal additive manufacturing. In Laser cladding technique, the influence of part build strategy, thickness of the deposit plays a major role in creating complex shapes. Since laser (heat) being the source of energy, the metallurgical characteristics of the deposits are some of key factors to be studied. This technology has evolved in the last fifteen years and came into commercial usage in the last decade, the scope for improvement is at large. In this deposition process, due to rapid cooling during solidification, high thermal gradient exists between the melt pool and the cold substrate and also many variables such as power, scanning speed and strategy, part geometry affects the post-solidification process and the corresponding microstructure gives an insight to the mechanical properties.

The repair/overhaul technologies are inevitable choices as replacement is far more expensive if only a small component gets damaged in the entire system. In the case of additive manufacturing, laser processing as a near-net-shape technique might help producing component with a geometry that is close to the final dimensions and also reduces post processing or post machining that may allow fitting the sizes of the finished part. In such techniques, obtaining the actual base material microstructure of the base material is difficult, but it's worthwhile to achieve from the repair process a microstructure in the deposit that is close to the original one in terms of metallurgical and mechanical properties.

The talk primarily focuses on cladding of Stellite 6 with a 4 KW fibre coupled diode laser to understand fusion, distortion, and cracks in single and multi track/layers deposits. The parameters investigated include clad geometry, dilution, microstructure and micro hardness with optical/SEM techniques for dimensional and micro-structural characteristics. Energy Dispersive Spectroscopy (EDS) is performed to estimate the content of Fe, Co and W. A dilution of 2-5% (geometrical & volumetric) is achieved. The results gave us an insight on how to build components of complex geometry out of Inconel 718 powders that are used in turbine blade industry. The SEM images revealed fine dendrite structure at low powers and a coarse structure at high powers. Cracks are observed in both single and multi layers beyond a certain laser power and a hardness of 583HV is achieved.

ICAMSF-024

Recent Trends in MEMS/NEMS-Based Biosensing and IoT-Integrated Flexible Sensors for Water Treatment and HER/OER Applications

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The rapid advancements in Microelectromechanical Systems (MEMS) and Nanoelectromechanical Systems (NEMS) have enabled the development of highly sensitive and miniaturized biosensors for various environmental and biomedical applications. This talk will focus on the integration of MEMS/NEMS-based biosensing platforms with machine learning (ML) and the Internet of Things (IoT) to achieve real-time monitoring and detection of volatile organic compounds (VOCs) and other critical contaminants. The discussion will highlight the role of flexible sensors in environmental monitoring, particularly in water treatment applications, where precision sensing is crucial for ensuring water quality. Additionally, the talk will explore the application of these advanced sensor technologies in the detection and enhancement of Hydrogen Evolution Reaction (HER) and Oxygen Evolution Reaction (OER) processes. The use of flexible, IoT-enabled sensor platforms allows for seamless integration with existing water treatment infrastructure, providing continuous monitoring and optimization of catalytic activities for sustainable energy applications. By leveraging machine learning algorithms, sensor data can be analyzed efficiently, enabling predictive maintenance and improved decision-making in industrial and environmental settings.

Overall, the convergence of MEMS/NEMS biosensing, ML, IoT, and flexible sensor technology holds immense potential for revolutionizing water treatment processes and advancing green hydrogen production. This talk will present recent advancements, challenges, and future perspectives in this rapidly evolving field, paving the way for innovative solutions in environmental sustainability and energy generation.

ICAMSF-025

Next-generation sustainable construction material for environmental remediation

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The construction industry is increasingly focusing on sustainability through efficient waste management and waste maximization. The present study aims to create a visible-active Fe-TiO_2 photocatalytic and sustainable construction material for environmental remediation. It uses cementitious materials with iron-rich industrial waste products to support nano-photocatalysts like Titanium dioxide (TiO_2), resulting in a Fe-TiO_2 composite with photocatalytic and antibacterial properties. The study introduces a natural doping concept to enhance the photocatalytic properties of the developed Fe-TiO_2 sustainable construction material. To assess the structural performance of the prepared sustainable cementitious material different physical (porosity, water absorption, and density) and mechanical (compressive strength, flexural strength, and split tensile strength) properties were performed. The results show that the cement mortar mixture FB5F having 15% (10% FA and 5% BS) proportion of conventional cement performed better in terms of workability and durability than other mix designs. Thus, the Fe- TiO_2 composite material proposes an eco-friendly concept which satisfies the requirement for a sustainable, circular-economy and low carbon footprint future which can additionally be used to treat different indoor and outdoor organic contaminants.

Keywords: Sustainable construction material; composite; industrial waste products

ICAMSF-026

Challenges in Nanomaterial-Based Herbal Delivery to Combat/Mitigate Antimicrobial Resistance (AMR)

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Antimicrobial resistance (AMR) is an uprising threat to one health. The conventional antibiotic pool is no longer effective, forcing the exploration of novel and alternative antimicrobial strategies. With a dearth of newer antibiotics in the pipeline, effective drug delivery strategies of existing antibiotics like nanotechnology are widely seen as promising approaches to overcome the challenge of AMR. Nanotechnological approach for delivering conventional antibiotics provides an opportunity to improve the efficiency of the antibacterial regimen through nanoparticles. The intrinsic antimicrobial activity of various types of organic and inorganic nanoparticles (NPs), and indeed nanoparticles own remarkable properties with respect to bulk material, which are extremely valuable for antimicrobial activity: small size and high surface area-to-volume ratio. Sustained and targeted antibiotic nanodelivery to infection sites renders substantial benefits over conventional formulations, including increased solubility, enhanced stability, improved epithelium permeability and bioavailability, prolonged antibiotic half-life, tissue targeting, and minimal adverse effects. The design of nanomedicine is a complex and demanding process

and the complexity of the phytoextracts further aggravates the imposed challenges. Despite the challenges, the potential benefits of nanoparticle-based drug delivery systems—such as enhanced bioavailability, controlled release, and targeted delivery—make them a promising avenue for future therapeutic interventions. With continued research and innovation, it is likely that these systems will play an increasingly important role in the development of new, effective treatments derived from plant extracts.

Keywords: Nanomedicine, Nanoparticles, Antimicrobial resistance (AMR), Drug-delivery

ICAMSF-027

Research Opportunities In (Nano-) Materials Science: New Avenues for Entrepreneurship

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In the first part of the talk, we will present our research work on optoelectronics, especially on transparent conducting electrodes (TCEs) and photonic materials. For instance, copper nanowire (Cu NW)-based TCEs present a promising alternative to traditional indium-doped tin oxide (ITO) TCEs. However, the susceptibility of copper to surface oxidation is a significant challenge. We will explore strategies to enhance the stability of Cu NW-based TCEs. To address this issue, we propose the use of polyimide (CPI) as a protective layer during the fabrication of Cu NW TCEs, which demonstrates outstanding stability. Conductivity measurements (resistivity) indicate that these TCEs maintain their performance over 90 days without significant degradation, in contrast to the reference TCE, which experiences complete failure in conductivity after approximately 15 days. We will also showcase the practical applications of our Cu NW TCEs by fabricating a thin film transistor (TFT) and an organic solar cell, both exhibiting good operational stability. Additionally, we will discuss the physics and engineering of surface plasmons (SP) in metal nanostructures and the emission characteristics of photonic crystals. These developments have opened avenues for optical information processing that surpasses the diffraction limit. We have successfully demonstrated plasmonic circuitry at the micrometer scale, which has valuable applications at telecom wavelengths by manipulating the single- photon emission behavior of photonic crystals. We will present experimental mapping of emissions from photonic crystals using confocal photoluminescence. Finally, we will address an intriguing question regarding the stability of organic-inorganic lead halide perovskites.

The 2nd part of the talk will focus on the areas of interest in materials science due to the recent policy shift aimed at cultivating a vibrant start-up ecosystem that has created significant opportunities for researchers across various disciplines. Key fields include materials science—particularly semiconductors and catalysts—along with the aerospace sector, renewable energy, the automotive industry, and quantum computing, especially in photonic materials. The transition from a traditional to a circular economy, driven by a shift to renewable energy, impacts nearly all major sectors, including automotive, sustainable building design, and energy-efficient devices. As the industrial sector moves toward lower energy consumption through various energy-saving initiatives, chemical industries likewise need to innovate new catalysts for chemical conversions. Addressing challenges like energy production from waste and converting bio-waste into valuable chemicals demands thorough investigation. Each of these sectors presents unique opportunities for start-ups. We will highlight how materials science, particularly nanomaterials, plays a vital role in fostering entrepreneurship.

Keywords: Conductivity Measurements, Surface Plasmons (SP), Thin Film Transistor (TFT)

ICAMSF-028

Optimizing Visible-Light Photocatalysis for Hydrogen Production and Wastewater Remediation: Challenges and Opportunities

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Photocatalytic and photoelectrocatalytic approaches to water splitting and organic reforming using nanoscale metal-based semiconductors offer great potential for sustainable hydrogen production by utilizing solar energy with minimal environmental impact. Integrating industrial and urban wastewater streams that contain specific organic compounds, such as carboxylic acids and alcohols, enables a dual-benefit process, that is simultaneous wastewater treatment and hydrogen generation. Despite decades of research focused on enhancing materials for effective solar energy capture, the efficiency of solar-to-hydrogen conversion remains insufficient for large-scale economic feasibility in practical applications.

This presentation explores photocatalytic water splitting and organic photoreforming, emphasizing metal-based semiconductor nanomaterials like Cu/TiO_2-based photocatalysts, which facilitate hydrogen production in aqueous media under both UV and visible light. To identify cost-effective and high-performance metal-based semiconductor nanomaterials for organic photoreforming, key factors influencing photocatalytic efficiency are analyzed. These include band gap energy and potentials, photostability in aqueous conditions, crystallinity, particle size, and specific photoactivity. Additionally, the influence of sacrificial organic compounds on the photoreforming process is discussed, alongside proposed reaction mechanisms. Lastly, a critical evaluation of recent advancements in the kinetics of photocatalytic hydrogen evolution over metal-based semiconductor nanophotocatalysts is presented.

This study aims to provide a strong foundation for the advancement of innovative, efficient, and economically viable metal-based semiconductor nanomaterials for hydrogen generation through solar-driven organic reforming of wastewater streams originating from industrial and urban sources.

Keywords: Photocatalytic and photoelectrocatalytic, Metal-based Semiconductor, Hydrogen Evolution, Cu/TiO_2 Photocatalysts.

ICAMSF-037

Friction and Temperature Analysis of Glass-Epoxy Composites with Waste Materials as Fillers under Ball-On-Flat Linear Reciprocating Wear

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This research explores the potential of utilizing clamshells: marine waste and cenospheres: industrial waste to create a novel class of hybrid glass epoxy composite materials. Glass fibre reinforced polymer composites are widely used for several engineering applications such as automobile components, medical

instruments, and in the aerospace industry. The composites are effective based on their properties such as lightweight, extreme durability, and so on, but at the same time, they have the most common disadvantage of wear, which necessitates improvement in the wear properties of fibre composites to facilitate good durability. The composites studied in this work are glass-epoxy composites with clamshell and cenosphere fillers. To assess their performance, a ball-on-flat linear reciprocating tribology test has been conducted on the developed composites to investigate friction and temperature variations during different cycles of linear reciprocating motion. The percentage of fillers selected for the research is 0 wt. %, 10 wt. %, 20 wt. % through the hand layup process. The results indicate that composites with added fillers exhibited higher dynamic friction and temperature evolution during the test process. The volumetric loss of cenosphere filled composites is found to be higher than the composites filled with clamshell filler during the test procedure. It is observed that the dynamic of friction increases for composites with increase in cenosphere filler but for clamshell filler it is decreased at 20 wt. %. The temperature that is generated is observed to be maximum for clamshell filler of 20 wt. % and the experimental volume loss increases with an escalation in filler content for both clamshell and cenosphere-filled composites.

Keywords: Glass fiber, polymer composite, clamshell, cenosphere, tribology

ICAMSF-040

Enhancing Ultrasonic Spot Weldability of Al-Brass through Surface Modification Techniques

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Ultrasonic spot welding offers numerous advantages in material joining, including cleanliness, high production rates, efficiency, and superior weld quality. The performance of ultrasonic spot welding is substantially determined by the contact and frictional dynamics at the joint interface, which are consequently influenced by surface modification techniques. Although the influence of sonotrode tip surface characteristics has been explored, the interrelated effects of process parameters and surface modifications at the joint interface on weld strength remain an area requiring further investigation. Surface roughness at the weld zone plays a critical role in achieving optimal joint quality. This study investigates the enhancement of ultrasonic weldability of aluminum-brass joints by employing four distinct surface conditions: lubricated, normal (as-received), electro-polished, and emery-polished. Results demonstrate a negative correlation between surface roughness and both tensile shear and T-peel failure loads. The lubricated condition exhibited the highest interfacial temperature. This resulted in the most significant grain refinement and the highest hardness at the faying surface. Fracture analysis revealed distinct ductile fracture modes under different surface conditions. This research contributes to a

deeper understanding of the influence of surface modifications on USW performance, particularly in dissimilar metal joining of aluminum and brass. The findings highlight the importance of controlling surface roughness to optimize weld strength and overall joint integrity.

Keywords: Ultrasonic Spot Welding, Surface Modification, Aluminum-Brass Joints, Friction Dynamics, Weld Strength, Fracture Analysis.

ICAMSF-042

An Earth Air Heat Exchanger - A sustainable solution to mitigate heat in building envelopes

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Presently, due to climate change, temperatures in various parts of the globe have risen dramatically, impacting the working efficiency of persons and machines. Due to the scorching heat, many people are unable to survive which also has an impact on cattle, crops, and industrial production. As a result, energy demand rises during the summer to keep buildings comfortable due to the use of air conditioners. In order to solve this issue, sustainable passive cooling methods that don't rely on finite fossil fuels can be used to cool the building envelope without harming the environment. The earth air heat exchanger (EAHE) is one of the passive cooling techniques suitable for Indian climatic and geographical conditions. Researchers have investigated its performance by various methods, which include the design of EAHE, its theoretical, numerical, and experimental investigation, the study of hybrid systems, etc. This paper provides light on the evolution of the sustainable EAHE system and its application in the Indian context.

Keywords: Earth Air Heat Exchanger, Passive Cooling, Thermal Performance, Hybrid System.

ICAMSF-043

An experimental investigation on thermal behaviour of hybrid agro-waste derived fillers reinforced 3D printed biocomposites

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The biodegradable polymeric composites can effectively replace the conventional composites. The polymeric composites are susceptible to the thermal degradation. The research aimed to investigate the thermal behaviour of the biocomposites. In the present study, four different biocomposites were developed by using polylactic acid with the reinforcement of a hybrid agro waste derived biofillers in different proportions includes 5, 10, 15 and 20 (wt. %) of orange and banana peel powder (in equal proportions). The biocompoistes were fabricated by employing 3D printing techniques. The intended application of the developed composite in automobiles like dashboard, door panels, switches, etc.

Differential thermal analysis (DTA) was performed to analyse the heat change of the biocomposites and Fourier transform infrared spectroscopy (FTIR) analysis was performed to identify the chemical relationship among the composite compositions and revealed insights into the structural attributes of lignocellulosic composites. These techniques offer a several crucial thermal events which are not easily identifiable. The thermal stability of the composites improves with the reinforcement of the biofillers and modifies the matrix crystallization as a result improves the adhesion. The developed biocomposite shows a comparable thermal performance to traditional polymer-based composites. The research findings facilities in the development of eco-friendly, high performance and biodegradable composites for diverse applications.
Keywords: Biocomposites; Chemical structures, Hybrid biofillers; Sustainable; Thermal analysis.

ICAMSF-044

Surface characteristics of EN31 alloy steel under different sustainable turning conditions: A comparative analysis

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Pollution in manufacturing environments is a pressing issue, driving continuous efforts to mitigate its effects. Among the various contributors, industrial cutting fluids or lubricants play a significant role in generating pollution. To address this, sustainable machining techniques such as dry machining and minimum quantity lubrication (MQL) have gained prominence as alternatives to conventional cutting fluids. Hence, the present study conducts a comparative analysis of machining performance in turning under three sustainable machining approaches by investigating the surface characteristics, such as roughness and texture, of EN31 alloy steel machined under dry conditions, MQL with water-soluble mineral oil, and MQL using aluminum oxide nanofluid (NFMQL). The experiments were conducted on a CNC turning center using coated carbide inserts as the cutting tools. Results indicate that surface machined under NFMQL conditions exhibit significantly lower average surface roughness (*Ra*) than dry and traditional MQL machining. Digital image processing was employed to comprehensively analyze the machined surface textures, providing insights into their statistical characteristics under these sustainable machining approaches. The analysis of filtered images revealed numerous dark spots and burnout areas on surfaces machined under dry conditions. These burnout spots were notably reduced in MQL machining and showed further improvement under NFMQL. Histogram equalization of the machined surface images showed a gradual reduction in both means and variance values.
Keywords: Minimum quantity lubrication (MQL), EN31 Alloy Steel, Histogram Equalization.

ICAMSF-045

Prediction of limiting strains and Fracture toughness of DDQ steel using stretching and incremental forming processes

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Sheet metal products have gained significant attention due to their low weight, reasonable strength, and ease of forming, making them ideal for various applications in aerospace, automotive, and architecture. However, during the forming process, sheet materials sometimes fail unexpectedly without any signs of necking, which poses a significant challenge. This study evaluates the fracture limits of DDQ steel sheets through the construction of both a Forming Limit Diagram (FLD) and a Fracture Forming Limit Diagram (FFLD) using stretching and incremental sheet forming (ISF) methods. Theoretical fracture limits are predicted using Oyane's damage model, with the results closely matching experimental findings from incremental forming, exhibiting an error of just 7.47%. Additionally, fracture toughness, as calculated from Double Notched Tensile Test (DNTT) specimens (R = 274.2 kJ/m²) and ISF (R = 280.2 kJ/m²), show strong correlation. The deformation behavior of DDQ steel sheets was also examined by forming hemispherical cups using both single and multi-stage ISF processes. Failures observed in single-stage forming were mitigated by employing different strategies in multi-stage forming. A new theoretical approach has been proposed to predict sheet thickness during multi-stage forming. Experimental and FE simulation analyses of forming forces, deformation energy, and component accuracy were conducted. Fractographic analysis of the fractured specimens formed by different processes revealed the presence of numerous dimples and voids, indicating that the failure mode was predominantly ductile with significant deformation.

Key words: Fracture toughness; Fracture limits; Multistage forming; Deformation energy; Form accuracy

ICAMSF-046

In-depth Study of Catalytic Performance of PMS Activated by Mn-based Material for Bisphenol A Degradation

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Bisphenol A, a well-known endocrine-disrupting chemical (ECD) is commonly detected in effluents from industries and wastewater treatment plants. It is extensively used in the production of polycarbonate and

epoxy resins. It is linked to serious environmental pollution as it threatens the health of humans and animals even at very low concentrations by malfunctioning the endocrine system through imitating or blocking natural hormones. Three-dimensional (3D) porous MnO_2 microspheres with excellent specific surface properties and high catalytic activity were synthesized via a simple co-precipitation method followed by calcination. The as-synthesized catalyst exhibited outstanding performance in activating peroxymonosulfate (PMS) for the degradation of bisphenol A. A systematic degradation approach was conducted to investigate by taking operational parameters as variables, such as catalyst amount, PMS dosage, initial bisphenol A concentration, solution's initial pH, reaction temperature, and co-existing anions. The results showed more than 92% degradation of bisphenol A was achieved within 120 min at pH 3.8, catalyst dosage = 0.5 g L^{-1}, PMS_0 = 0.2 mM, and temperature = 328K for a solution of bisphenol A = 20 mg L^{-1} by PMS/MnO_2 system. Furthermore, reactive species in the PMS/MnO_2 system were examined by electron paramagnetic resonance (EPR) studies and scavenging experiments. Sulfate radicals (SO_4^{2-}), Hydroxyl radicals ($^{\bullet}OH$), and singlet oxygen ($^1O_2$) are the participating active species that effectively participated in the oxidative-reductive mechanism of bisphenol A degradation. Furthermore, the organic compounds as intermediates of the degradation process were identified by LC/MS. Based on intermediates analysis, a possible stepwise degradation pathway of bisphenol A and the role of MnO_2 microspheres in PMS activation have been proposed.

Keywords: Endocrine-disrupting chemicals, Peroxymonosulfate activation, catalytic degradation, bisphenol A

ICAMSF-047

Multi-variable optimisation of AWJM process using wighted-grey relational method for Ti-6Al-4V alloys

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Water driven technology powered by absrasive particles, Abrasive water jet machining (AWJM) is a highly efficient modern machining processes that allows the processing of various materials without altering their properties. Titanium alloys are used in multiple applications, like aircraft engines, surgical instruments, and medical implants. Precise processing of of titanium alloy with convetional and erosion-based methods is difficult because it has poor thermal conductivity, to overcome this issue AWJM is opted for machining. The trials are performed in accordance with the Taguchi L25 orthogonal array. Employement of research surface Methodology (RSM) to determine the optimal process parameters has been accomplished in this study. Controlled variables considered for optimisation are water pressure(P), nozzle head speed term as trasverse speed (TS), gap between nozzle tip and workpiece (SOD stand off distance) and abrasive feed rate(AFR).The integration of the weighted-Grey Relational Analysis (w-GRA) approach enables the analysis of measured machining performances, such as Machining time (MT) time taken to ensure 12 mm hole upto 10 mm thorough cut , Surface roughness (SR), and Hardness (HRC). The position $P_4AFR_4SoD_2TS_1$ represents the location for the maximum GRG, which suggest that highest pressure and AFR condition for achievement of best result with maximum speed targeted from lower distance. ANOVA revealed that the MMP is significantly impacted by factor P, followed by factors quality which represents tranverse speed. AFR and SoD have minimal influence in combined effect study. The participation percentage is as follow of 82.58 %, 9.79%, 3.39%, and 2.80%, respectively.

Improvement in the machine performance is microscopically analysed and influence upon mechanism is explained.

Keywords: Abrasive Water Jet Machining (AWJM); Trasverse Speed (TS); Machining Time (MT).

ICAMSF-050

Performance Study of Carbide Cutting Tool in High-Speed Turning of Hardened AISI4340 in Hybrid MQL and Cryogenic Condition

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Machining is one of the important manufacturing processes in the manufacturing industry. The performance of the carbide cutting tools in machining hardened AISI 4340 steels under hybrid lubrication conditions by combining Minimum Quantity Lubrication (MQL) with liquid nitrogen (LN2) cryogenic cooling was studied at various combinations of machining parameters at high-speed range machining parameters for AISI 4340. The range of cutting speeds, V, was between 300-350 m/min, feed rates, f, 0.05-0.1 mm/rev, and depths of cut, d, 0.1-0.2 mm. The Taguchi L4 method was used to arrange the experimental runs to minimize the number of experimental runs. The experimental results revealed that at the combination parameters of V=300 m/min, f=0.05 mm/rev, and d=0.1 mm resulted in the longest tool life of 54.7 minutes. Whereas at this cutting speed and feed rate the minimum Ra value was 0.182 µm at d=0.2 mm, and the minimum cutting force obtained was 57.97 N at d=0.1 mm. Additionally, the depth of cut is the most critical parameter affecting the cutting force, surface roughness, and tool life in the high-speed turning process of hardened AISI 4340. Analysis using SN ratio in determining the optimum cutting conditions were at cutting speed of 350 m/min, a feed rate of 0.05 mm/rev, and a depth of cut of 0.1 mm, which can result the best balance between productivity and quality. The main wear mechanisms observed at the flank face included abrasive wear, coating delamination, adhesive wear, and oxidation wear with long and continuous chips were formed. This approach has the potential to significantly improve machining efficiency. The study of wear mechanisms under MQL+Cryogenic conditions will contribute to a comprehensive understanding of the machining process. The findings of this study can provide important guidance for machining hardened AISI 4340 in the high-speed regime.

Keywords: Carbide Cutting Tool; Hybrid Lubrication; AISI 4340; Tool Life; Surface Roughness; Cutting Force

ICAMSF-051

A Comparative Study of Copper and Brass Electrodes in Multi-axis Near Dry EDM: Machining Performance and Economic Assessment for IN718

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In the present study, the performance parameters of Multi axis Near-dry EDM process are to be evaluated to achieve the feasibility in machining of Inconel-718 which offers extensive applications in aerospace and gas turbine industries. The low thermal conductivity and high work-hardening characteristics of Inconel-718 make it difficult to machine. Here, the machining is done using in-house developed Multi-axis Near-dry EDM (MX-ND-EDM) setup, in order to select a suitable electrode material for the newly developed process in this study L_9 orthogonal array is applied for experimental investigations with two different electrode materials, namely copper (Cu) and brass (Br). In order to improve the multi response characteristics, including MRR and EWR, on IN718 Taguchi's signal-to-noise ratio is implemented in this work. The best possible combination of control parameters, including current, voltage, and pulse-on-time, has been identified. The results have shown that, for all the current settings, brass electrode provides the highest material removal rate (MRR = 10.21571mm^3/min), followed by copper electrode (MRR = 5.37241 mm^3/min). However, Cu exhibited the lowest electrode wear rate (minimum EWR = 4.582 mm^3/min & maximum EWR = 5.742 mm^3/min), followed by Br electrode (minimum EWR = 12.119 mm^3/min & maximum EWR = 14.075 mm^3/min). Moreover, the surface characteristics of the electrodes after machining were investigated as well.

Keywords: Inconel-718**,** MX-NDEDM, Electrode Material, MRR, EWR

ICAMSF-052

Metamaterial based reflectarray antennas-A review

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Metamaterials are influencing daily life by transforming technologies in communication, healthcare, energy efficiency, and more. These advancements demonstrate the transformative impact of metamaterials on antenna technology, enabling applications in telecommunications, aerospace, defence, and beyond. Metamaterial based Reflectarray antennas provide improved signal strength and reduced interference. High-performance metamaterials are essential for next-generation wireless technologies, enabling faster and more reliable internet connectivity in smart devices. This paper discusses the metamaterial Reflectarray antenna classifications based on broad band operation, Performance parameter enhancement and space Applications.These classifications of metamaterial reflectarray antennas are smaller, lighter than conventional Reflectarray antennas. Reflectarray antennas employing metamaterials overcomes restrictive efficiency, bandwidth limitations for conventionally constructed miniature antennas. Metamaterials allow smaller antenna elements that cover a wider frequency range, thus making

better use of available space for space-constrained cases. Metamaterial reflectarray antennas are attractive options for reducing system SWaP (size, weight, and power) compared to conventional reflector antennas. However, it has been a long-held belief that metamaterials are unsuitable for high-power microwave applications due to their strong field enhancement behaviours. Here this challenge can be overcome by judiciously combining state-of-the-art optimization with intelligent material selection and metamaterial geometry. The designed deployable reflector *antenna* is found to be suitable for microsatellite applications also due to small volume, small weight and low cost. In conclusion, this review of metamaterial reflectarray antennas overcomes the advantages of conventional antennas and suggested some good solutions to realize innovative antennas.

Keywords: High-Performance Metamaterials, Reflectarray Antennas, Bandwidth.

ICAMSF-053

Multi-Axis Near-Dry Electrical Discharge Machining Behavior and Characterization for Nimonic-81 Superalloy

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In the current research work, machining has been done on Nomonic – 81 superalloys through the in-house developed Multi-Axis Near-dry Electrical Discharge Machining. Nickel based super alloys have grown in popularity in recent years due to their widespread application in the oil and gas, automotive, biomedical industries, marine, and aerospace. The DoE has implemented by Taguchi is used in all the experimental trials for testing with three process parameters: voltage, pulse-on-time, and discharge current for experimentation purposes while pulse-off-time, dielectric pressure, dielectric fluid, electrode material, and polarity is kept constant throughout the experiments. The process parameters are optimized to achieve high material removal rate (MRR) with minimum energy consumption. In case of MRR, the pulse-on time and peak current are found as significant factors with increasing trend. The optimum values for maximum MRR = 3.53598 mm3/min during near-dry EDM is obtained for the process parameter as 18 µs pulse-on time, 1000 A peak current, and 60 V voltage. The machined surface morphology was examined, a clear layer of EDMed surface on the workpiece is identified by the microcracks, can be seen in the SEM micrographs.

Keywords: Nimonic-81, MRR, Ppolarity, Dielectric Fluid, Pulse-on-time, Pulse-off-time, Current, Voltage.

ICAMSF-056

Analysis of Transmission Performance of Glass Fiber-Reinforced Functionally Graded PA 66 Composite Spur Gears

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Polymer composite gears are applicable under low and moderate loading conditions. Performance wise, polymer composite gears are better than neat polymer gears. A large number of applications have replaced metallic gears with polymer gears in recent years. They have little inertia, lower weight, and produce far less noise than metals or other materials. In this work, polyamide 66 (PA66) having glass fibers of 15 wt % and 30 wt % are used to fabricate the homogeneous as well as functionally graded materials (FGMs) based composite gears. Gears are manufactured by injection molding method using centrifugal casting technique. Ignition loss test, SEM analysis and hardness measurement is used to verify the gradation of fibers inside the FGM gears. The objective of this work to portrays the investigation of transmission efficiency comparatively for homogeneous gear and FGM gear in operation. Polymer gear test rig is used to perform the experimental work. The experiments are conducted for various speeds to torque combinations for a period of 0.2 million cycles. The range of the torque is 0.8-2.6 Nm and that for the rotational speed is 500-1400 r/min. It can be inferred that applied torque is having a more significant effect on transmitted efficiency of gears compared to rotational speed.
Keywords: PA 66; Glass Fiber; FGM gear; Gear test rig; Transmission efficiency

ICAMSF-057

Tribological Performance of Polymer Composite Filled with Production Waste

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Currently, numerous studies are being conducted in the field of obtaining Thermo-reactive polymer composite materials and producing high-responsibility parts based on them in the field of mechanical engineering. The main advantages of such materials are the low cost of production technology and raw materials compared to metals, replaceable when used as parts, wear resistance, and self-lubricating properties. This article examines the content of fillers and the degree of their influence on the properties of ED-20-based thermosetting polymer composite materials. To ensure the self-lubricating properties of the material in the production of wear-resistant composite materials, "pec" was used as a filler, which is the residual waste formed during the thermal processing of gas. It has been established that the content of carbon-containing pecs in the composite material exceeds 5-6%, and they can change the tribological properties of the composite material to a lesser extent. The morphological analysis of peck and the number of compounds in its composition have been studied. Mechanical activation of fillers ensures their

uniform distribution across the structure of the composite material. The composition of the material with the best tribomechnical properties was determined using experimental studies, and the value of the friction coefficient in wear was reduced to 0.14. In addition, fiber fillers were used to ensure sufficient strength along with the hardness of wear-resistant polymer composite materials, and their optimal amount was determined. The article concludes by examining the prospects of thermosetting polymer-based composite materials and highlighting the advantages of their use.

Keywords: Thermoreactive polymer, ED-20, peck, filler, composite, tribological properties, morphology, friction, insole.

ICAMSF-059

Power Quality Disturbance Mitigation in Grid Systems Using Grey Wolf Optimization

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Significant simulation work was done in this paper to investigate the efficient operation of Distribution Static Synchronous Compensator (D-STATCOM) and Grey Wolf Optimization (GWO). D-STATCOM and GWO simulation models are displayed using MATLAB SIMULINK. The simulation findings for (a) three phase issue (b L-L-G issue (c) L-G issue for voltage dip and fair L-L-L fault for current swell were discovered. Using D-STATCOM and GWO, the aforementioned three types of faults for voltage sag and current swell were discovered, compared, and removed. The new optimisation technique GWO was applied to D-STATCOM, yielding new and improved results. A novel optimisation technique known as GWO has been adopted to get better the working effectiveness of the Distribution System. The results of employing GWO have been quite positive, with further reductions in voltage dip and current rises in the load system.

Keywords: Grey Wolf Optimization (GWO), MATLAB SIMULINK, D-STATCOM, Optimisation Technique.

ICAMSF-060

High temperature wear behavior of aerospace grade Ti-6.5Al-4Zr-2.8Sn-0.2Si alloy

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High temperature wear behavior of aerospace grade Ti-6.5Al-4Zr-2.8Sn-0.2Si alloy was investigated under dry sliding conditions with temperature varying from RT to 400°C. Various parameters such as load, sliding distance, and temperature were considered to determine the wear rate. The alloy shows excellent wear resistance at 200 °C temperature when compared with RT and 400 °C. Post wear analysis was carried out on the worn surface as well as in wear debris

using scanning electron microscopy equipped with energy dispersive spectroscopy (SEM-EDS). The wear analysis revealed that the delamination of oxide layer from the specimen surface attributed to the inferior wear resistance at 400 ℃. The presence of titanium dioxide (TiO_2) particles on the worn surface of samples indicates that the oxide scales act as lubrication which improved wear resistance of the alloy at 200 ℃.

Keywords: Titanium alloy, Wear, Self-lubrication, High temperature, Delamination wear.

ICASMF-063

Micro-scratching behavior of ultrafine nano-grained Brass260 sheet metal produced through large strain extrusion machining (LSEM)

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Brass260, an alloy of copper and zinc, is renowned for its superior machinability and exceptional corrosion resistance in harsh environments. However, its wear behavior, a critical aspect influencing performance during relative motion in specific applications, has not been gaining prominent attention. Therefore, the current study investigated the frictional behavior of bulk ultrafine nano-grained Brass260 sheets/laminates produced through large strain extrusion machining (LSEM) to establish a correlation between structure and properties. The frictional behavior of LSEMed brass260 was investigated using a micro-scratch test in progressive load mode from 20 N to 40 N and a constant scratch speed of 10 N/mm to analyze their influence on wear performance. LSEM is known for its ability to induce severe plastic deformation (SPD), which generates bulk ultrafine nano-grained sheets with unique textured features suitable for wear behavior. Such features may improve the material's wear resistance, making them a promising focus for research in applications that demand high-performance materials. Eventually, the micro-hardness test was also conducted on bulk nano-grained sheet metal, with the laminates achieving a maximum micro-hardness of 250 Kgf/mm². This significant increase in hardness is attributed to the refined microstructure and work hardening induced by the LSEM process due to the high degree of deformation. Scanning electron microscope and 3D optical profilometer were used to examine the worn surfaces, revealing the depth and width of scratch scar and distinct wear mechanism i.e., abrasive and adhesive wear patterns. Subsequently, the coefficient of friction (COF) was found to vary from ~ 0.2 to ~ 0.4, depending on the processing condition of sheet metals and test parameters. The friction force peaks at ~ 16 N, corresponding to a normal load of ~ 40 N. This indicates that the processed material maintains consistent frictional behavior across the mentioned load range. Wear rate analysis reveals that laminates produced through LSEM process exhibit superior wear resistance compared to the solution-annealed (SA) sample, with lower wear rates observed in the direction perpendicular to laminate formation direction. These findings were linked to microstructural evolution and key material properties, such as hardness, strength, and ductility, to provide insights into the factors influencing their wear performance.

Keywords: Brass260 sheet/laminate, large strain extrusion machining, ultrafine nano-grained material and micro-scratching behaviour.

ICAMSF-064

Harnessing Waste Heat: Optimizing ZnO-Based Thermoelectric Materials for Sustainable Energy

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In industrial processes, significant heat energy is often lost as waste, prompting extensive research into technologies for efficient waste heat recovery and reuse to support a cleaner environment. Thermoelectric materials and devices offer a promising solution for converting this waste heat into usable energy. This study presents three computational models based on ZnO thermoelectric material to evaluate energy harvesting potential: (i) a homogeneous model with a grain size of 0.18 µm, (ii) a homogeneous model with a grain size of 1.2 µm, and (iii) a functionally graded model with a grain size gradient transitioning from 0.18 µm to 1.2 µm along its length. Optimizing thermoelectric properties of the graded model using Power's law, a significantly enhancement in voltage and power output is observed, improving the overall energy conversion efficiency. Comparative analysis indicates a peak voltage of 15,168 µV and a maximum power output of 230 µW. The maximum figure of merit obtained is 4.22×10^{-3} at 675 K. The results highlight the potential of functionally graded ZnO thermoelectric materials for clean and sustainable energy recovery from industrial waste heat.
Keywords: Thermoelectric; functionally graded ZnO; TED; Seebeck effect.

ICAMSF-065

Multi-variable Optimization in spark erosion machining using weight assignment methods-ANN integration for AISI420 stainless steel

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The current research focused on spark erosion machining applied to AISI420 stainless steel. An experimental inquiry was undertaken, targeting three machine control parameters: Gap voltage, pulse current, and pulse on time. The ensuing responses under scrutiny encompassed material removal rate (MRR), electrode wear rate (EWR), and surface roughness (SR). By utilizing Python programming language, experimental designs were formulated based on the response surface methodology, specifically employing a central composite design. Subsequently, response plots were generated to elucidate the impact of input variables on various responses. Five levels were chosen for each parameter, totaling 20

experiments. The significance weights for the responses were allocated through a combination of weighted and Entropy methods. Analysis of variance was executed to discern the impact of process parameters on its overall effectiveness. The analysis of variance (ANOVA) elucidates the hierarchy of influence among machine control variables, with pulse current exerting the greatest impact, followed by gap voltage, and pulse on Time. Notably, Pulse current emerges as the predominant parameter. The utilization of artificial neural network (ANN) aimed to optimize process performance. The findings indicate that the ANN predictive model exhibits enhanced accuracy. Future attempts may use more advanced artificial intelligence methods like ANN-GA, ANN-PSO, etc.
Keywords: Spark Erosion Machining; AISI420 stainless steel; Artificial Neural Method; Weighted and Entropy Method; Analysis of Variance

ICAMSF-066

Effect of Post-Processing Treatments on Improving the Mechanical and Tribological Performance of SLM-Fabricated AISI H13 Tool Steel

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In this work, samples of AISI H13 tool steel made with the Selective Laser Melting (SLM) additive manufacturing process are examined for their mechanical and tribological characteristics. After manufacture, the samples were subjected to two different processes: heat treatment to improve hardness and mechanical performance, and sintering to reduce any remaining stress. Extensive analyses were conducted to determine how hardness affected the samples' mechanical and tribological behaviour in various scenarios. When compared to their sintered and as-printed counterparts, the heat-treated samples showed better mechanical and tribological qualities. Under moderate loading circumstances, the wear resistance was greatly increased by the increased hardness brought about by heat treatment. However, the beginning of abrasive wear, which is typified by the presence of large flake-like debris, enhanced the wear rate of the heat-treated samples under high loading circumstances. The as-SLM printed samples, on the other hand, showed less hardness and were primarily exposed to adhesive wear mechanisms and distortion during wear testing. Because of the mild increases in hardness and partial relief of residual stresses, the sintered samples performed in an intermediate manner, with characteristics ranging between those of the heat-treated and as-printed samples. This study emphasises how important post-processing procedures are to maximising the performance of AISI H13 tool steel that is SLM-fabricated. Heat treatment introduces a trade off under extreme loading circumstances because of abrasive wear, even if it greatly increases hardness and overall wear resistance. Customising the qualities of additively built components for particular applications requires an understanding of the wear processes and mechanical behaviour related to various processing states.
Keywords: Additive Manufacturing; AISI H13 tool steel; Tribology; Wear and Friction; Characterization

ICAMSF-069

Experimental investigations on laser cladding of Ni-WC coating on SS410

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Laser cladding is an advanced surface engineering technique for improving surface properties of a material by depositing a layer of material on the substrate. This process creates a metallurgical bond between the cladding material and the substrate, producing a hard, wear-resistant, and corrosion-resistant coating. Laser cladding has many applications such as in aerospace, automobile, oil and gas, and tool and die industries. Laser cladding produces high-quality coatings with minimum dilution, minimal distortion, good metallurgical bonding, small heat affected zone and improved surface quality. Laser clad nickel-tungsten carbide (Ni-WC) coatings have demonstrated tremendous potential for improving wear resistance in harsh operational conditions. In this paper Ni-WC coatings were deposited on a SS410 substrate in order to evaluate the effect of input parameters on the wear resistance of the coatings. The cladding powder is a combination of fused tungsten carbide (WC) (60% wt) and Ni-alloy (40% wt). The microstructural examination is performed by Scanning Electron Microscope (SEM) and Energy Dispersive Spectroscopy (EDS), further hardness of the coating is evaluated using microhardness tester and tribological properties of the coatings were studied by wear testing under dry sliding conditions. The results show that the hardness and wear resistance of the coating are significantly improved by the addition of WC particles to the Ni matrix. The coatings prepared with laser power 2400 W and scanning speed 12 mm/s exhibited excellent wear resistance. The wear mechanisms were identified as a combination of abrasive and adhesive wear.

Keywords: Ni-WC coatings, Laser cladding, Laser power, Scanning speed, Wear resistance

ICAMSF-071

Effect of MoS_2 and Al_2O_3 on Dry Sliding Friction and Wear Performances of Copper Hybrid Composites Developed by Microwave Sintering

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The current research work is primarily emphasized on the synthesis of new kind of copper metal matrix hybrid composites using the advanced microwave sintering (MWS) technique to overcome the poor mechanical and tribological responses of the copper metal. Where, hard alumina (Al_2O_3) ceramic and

comparatively softer molybdenum disulphide (MoS_2), including chromium (Cr), were reinforced in the matrix of copper. There was total four copper based hybrid composite materials developed by microwave sintering as per the different weight percentages (wt. %) of reinforcements and designated as MWSHC-0, MWSHC-1, MWSHC-2, and MWSHC-3. The high-resolution scanning electron microscope (HRSEM), high resolution X-ray diffraction (HRXRD), and energy dispersive analysis of X-rays (EDAX), including the elemental color mapping, were utilized to characterize the synthesized copper-based hybrid composites. HRXRD, HRSEM, and EDAX, including elemental color mapping analysis, exposed the reinforcing particles' presence and its fair distribution in the copper matrix with its superior interfacing. The electrical conductivity of synthesized hybrid composites was also investigated and revealed no significant loss in electrical conductivity of copper on the ceramic reinforcements. The experimental density of the synthesized hybrid materials was also evaluated and found that it was decreasing with increasing content of reinforcements. However, the Vickers hardness of the developed materials increases as the reinforcement content increases, hardness was investigated using the Vickers hardness tester. The wear test was performed for the developed hybrid composites using pin-on-disk arrangement under dry conditions. The friction coefficient and weight loss were decreasing as the reinforcement content of alumina and molybdenum disulphide increased. It may be attributed to the self-lubricating action of the MoS_2 reinforcements in the matrix. The worn surfaces of the investigated specimen were also analyzed using the SEM and EDAX to reveal the involved wear mechanisms as well.

Keywords: Microwave Sintering (MWS); Hybrid Composites (HC); Hardness; HRSEM; EDAX; HRXRD; Electrical Conductivity; Density; Friction; Wear; CoF

ICAMSF-072

Performance analysis and optimization of sae10w30 lubricant blended with nano-additives using ann for enhanced tribological, rheological, and thermal properties

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Base lubricant oils are typically blended with nano additives to enhance their lubrication characteristics. This study explores the enhancement of SAE10W30 base oil by incorporating nano additives (SiO_2, TiO_2, and Al_2O_3) to improve its tribological, rheological, and thermal properties. A full factorial design of experiments was used to prepare 27 samples with varying nanoparticle weight percentages (0.05%, 0.5%, and 1%). An artificial neural network, trained with data from 810 samples, was employed to predict the properties for 8,000 combinations of nano additives. This analysis identified the optimal combination that minimized wear and friction while ensuring desirable viscosity, density, and thermal stability. Sequential Least Squares Programming optimization determined the optimal blend as 0.05 wt.% SiO_2, 1 wt.% TiO_2, and 1 wt.% Al_2O_3. The optimized blend achieved a specific wear rate of 0.00411 mm^3/Nm, a coefficient of friction of 0.03604, a density of 0.9373 g/ml, a flash point of 192.3°C, a fire point of 214.9°C, and a kinematic viscosity of 14.67 m^2/s. The blend was validated through real-time testing on a crankshaft-bearing assembly and analyzed using high resolution scanning electron microscope, which revealed significantly reduced wear and improved surface conditions compared to conventional oil. These findings

highlight the potential of nano additive-enhanced oils for advanced lubrication applications, offering promising benefits for industrial use and future research in nano-lubricants.

Keywords: nano additives, lubricant properties, optimal mix, factorial design, artificial neural network

ICAMSF-073

Wear Behavior Evaluation of Aluminium Matrix Composites Fabricated Using Waste Aluminium Scrap and Reinforced with Yttria Stabilized Zirconia by Ultrasonic-Assisted Squeeze Casting

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The study aims at the fabrication and tribo-performance investigation of aluminium matrix composites on waste aluminium as matrix material, incorporating yttria-stabilized zirconia (YSZ) as reinforcement. Composite Samples of neat aluminium, Al+2% YSZ, Al+4% YSZ, and Al+6% YSZ were produced using an ultrasonic-assisted squeeze casting method employing ultrasound to improve particle distribution and defect reduction. Microstructure studies show that YSZ particles were homogeneously dispersed and increased with the progressive amount of reinforcement added. Wear studies were conducted on these under different loads and slide distances, indicating that the wear rates for YSZ-reinforced composites were far below those of neat aluminium. The sample Al+6% YSZ appears to have the best wear resistance owing to the load transfer synergism with the hard ceramic particles against material loss. The results of this study open up avenues for recycling waste aluminium scrap reinforced with YSZ in the manufacture of sustainable composites improving the wear performance.

Keywords: Aluminium matrix composite, Ultrasonic-assisted Squeeze casting, Yttria-stabilized Zirconia, Wear resistance, Waste recycling

ICAMSF-074

Fabrication and Wear Studies of AA2024 Aluminium Hybrid Composites Reinforced with Waste Industrial Stainless Steel (SS) powder and Eggshell Powder by hot press sintering

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This study focuses on the synthesis of hybrid aluminium metal-matrix composites using AA2024 aluminium powder as a matrix and waste industrial stainless-steel (SS) burrs with eggshell (ES) powder as reinforcements for making composites AA2024, AA2024+2%SS+1%ES, AA2024+2%SS+1.5%ES, and AA2024+2%SS+2%ES under the hot press powder metallurgy method. Microstructural analysis confirmed the uniform distribution of reinforcements within the matrix. The wear tests have shown hybrid composites to be superior in wear resistance compared to the neat AA2024 sample; they show the highest wear resistance for the AA2024+2%SS+2%ES composite. This improvement is due to the synergistic strengthening effect of hard SS particles and calcium-rich ES powder enhances hardness and wear resistance. This study proves the feasibility of fabricating low cost, sustainable composites using waste industrial and biological source materials that have improved mechanical properties.

Keywords: aluminium matrix composite, hybrid reinforcement, stainless steel burrs, eggshell powder, wear resistance, powder metallurgy

ICAMSF-075

Role of Multiwalled Carbon Nanotube Reinforcement on Welding Characteristics of Thermoplastics under Varying Tool Traverse Speeds

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The study investigates the effect of multiwalled carbon nanotube (MWCNT) reinforcement on the welding properties of dissimilar thermoplastics, acrylonitrile butadiene styrene (ABS), and polystyrene (PS) in friction stir welding (FSW). Experiments were conducted at constant tool rotation speeds (TRS) of 600 rpm and varying tool traverse speed (TTS) from 0.1 mm/s to 0.4 mm/s, both with and without the incorporation of MWCNTs. Results revealed that the ideal combination was a tool rotational speed (TRS) of 600 RPM and a tool traverse speed (TTS) of 0.2 mm/s., which produced high-quality joints. The influence of multiple passes on MWCNT distribution within the ABS and PS matrices is also included. The tensile testing demonstrated higher joint strength and improved joint efficiency with MWCNT reinforcement at TTS of 0.2 mm/s. These findings highlight the potential of MWCNTs to enhance the mechanical and microstructural properties of friction, which stir significantly welded dissimilar thermoplastics, offering new possibilities for advanced polymer-based applications in industrial sectors.

Keywords: Friction stir welding, Acrylonitrile butadiene styrene (ABS), Polystyrene (PS), Joint strength, Multiwall carbon nanotubes (MWCNTs).

ICAMSF-076

Microwave-Aided Fabrication of Natural Fiber Hybrid Composites: A Synergistic Approach to Mechanical, Wear, and Computational Property Analysis

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This study employs an energy-efficient microwave-aided composite molding technique to investigate the advancement and efficacy of HDPE-based hybrid composites reinforced with natural fibers, namely ramie and kenaf. Alkali treatment was performed on ramie and kenaf before using them to fabricate composites. The optimal parameters for composite fabrication were found to be 600 W of microwave power for 720 ± 30 seconds of processing time. Mechanical testing demonstrated substantial enhancements in the characteristics of the hybrid composite relative to pure HDPE, including a 24.1% increase in ultimate tensile strength (24.2 ± 1.3 MPa), a 10.6% rise in Shore D hardness (59.2 ± 2.5), a 32.3% improvement in flexural strength (18.3 ± 0.9 MPa), and a 28.5% augmentation in impact strength (23.6 ± 1.4 kJ/m²). The investigation of wear behavior revealed that wear and specific wear rate (SWR) escalated with increasing sliding speed, load, and duration, with HDPE exhibiting markedly greater wear and distortion, especially at a sliding speed of 3 m/s and a normal load of 30 N. The hybrid composite exhibited superior wear resistance, with negligible SWR increases at lower loads (10–20 N) at moderate sliding velocities.

Friction studies indicated that the hybrid composite had decreased and more uniform friction forces, even under increased loads and velocities. At the same time, HDPE exhibited 50% greater friction forces accompanied by thermal softening and adhesive wear. The study of scanning electron micrographs of worn surfaces indicated that wear processes progressed from mild adhesive wear at 1 m/s to severe abrasive and thermally aided wear at 3 m/s. The HDPE matrix underwent considerable degradation, whereas natural fibers demonstrated superior load bearing capacity, improving the hybrid composite's overall stability and tribological performance. An experimental Young's modulus of elasticity was used to evaluate the Mori Tanaka and Double inclusion approach computational model for natural fiber hybrid composites in this study. Mori-Tanaka technique and double inclusion yield composite Young's modulus within 10% of experimental values.

Keywords: Microwave-aided composite, Mori-Tanaka technique, Young's modulus, Tribological performance

ICAMSF-079

Synthesis of ethanolic extract of Buddhist Pine leaves and its deposition on copper's surface for corrosion prevention in salty water

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Natural materials (NM) have proven capability to prevent corrosion of metals in different media. The organic compounds of NMs actively interact with metals, cover them against corrosive molecules and thus protect metals. This work reports a similar kind of NM for the corrosion prevention of copper (Cu) in salty water (0.5 M NaCl). The ethanolic extract of Buddhist Pine leaves (EEBPL) has been prepared by simple extraction method and tested by UV-visible spectroscopy (UVS), FTIR spectroscopy (FTIS), and ^{1}H nuclear magnetic resonance spectroscopy (NMR). They confirm the richness of EEBPL in biomolecules. EEBPL has been deposited in layers (1-4) on Cu by drop casting (DC). The corrosion testing of coated Cu in salty water has been done by monitoring their open circuit potentials (OCP), impedance behavior through impedance spectroscopy (EIS), and polarization behaviors. The testing results suggest that Cu coated with 3 layers of EEBPL provide the best protection to Cu among tested ones. The surface analysis has also been performed by field emission scanning electron microscopy (FESEM) and energy dispersive X-ray (EDX) analysis, which suggest that EEPBL covers the Cu and protect effectively in salt water. A schematic for corrosion prevention has also been proposed based on results analysis.

Keywords: Corrosion; NaCl; Buddhist Pine; Drop Casting; EIS; FESEM.

ICAMSF-081

Wear Performance Enhancement in Glass-Epoxy Composites with Clamshell and Cenosphere Fillers for Industrial Application

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This research explores the potential of utilizing marine waste, specifically clamshells, and industrial waste in the form of cenospheres to create a novel class of hybrid glass epoxy composite materials. To assess their performance, a dry abrasion test was conducted on these composites, considering factors such as filler content (ranging from 0% to 20% by weight), applied load (from 70.1 N to 146.7 N), sliding velocity (between 1.5 m/s and 2.1 m/s), and sliding distance (ranging from 75 m to 125 m) as the four major process parameters. The wear experiments followed the Taguchi methodology and employed an L27 orthogonal array to determine the optimal process parameters for minimizing wear in the composite materials. The introduction of fillers into the glass epoxy composites significantly improved their resistance to dry abrasion. Notably, the applied load emerged as the most influential factor affecting abrasive wear in these composites. For composites containing 10% filler, cenosphere-filled composites exhibited superior wear resistance. However, in composites with 20% filler, those filled with clamshells experienced less wear. Subsequently, the abraded surfaces of the composites were examined under a scanning electron microscope, and the potential mechanisms of abrasion were comprehensively analysed and presented.

Keywords: Glass fiber, polymer composite, clamshell, cenosphere, tribology

ICAMSF-082

Multi-Response Optimization of µ-ECDM Process Parameters for Machining of Micro-Hole in Silicon Wafer Material Using Taguchi- Grey Relational Analysis (GRA) Technique

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Micro electrochemical discharge machining (µ-ECDM) is an advanced hybrid machining process that combines electro-discharge machining (EDM) and electrochemical machining (ECM) processes. This machining process is used for both conductive and non-conductive materials. Semiconducting materials like silicon, germanium, and tellurium are in high demand in micro-electro-mechanical systems (MEMS) applications like lab-on-chip devices, micro pumps, micro sensors, other electronic devices, etc. In this study, a micro hole was drilled on a silicon wafer as a workpiece by varying the input process parameters like applied voltage, electrolyte concentration, and tool feed rate at three different levels. To investigate the impact of several process factors, such as applied voltage, tool feed rate (TFR), and electrolyte concentration, on the output quality characteristics, such as radial overcut (ROC) and material removal rate (MRR), the experiments were designed utilizing Taguchi's technique using a L9 orthogonal array. The material removal rate, and radial overcut are the primary characteristics of microholes that have been measured. The machining process parameters are optimized using the multi-response analysis -Grey Relation Method. The detailed results are discussed in this paper.

Keywords: Grey relational analysis**,** μ-ECDM, material removal rate, radial overcut, tool feed rate.

ICAMSF-083

Investigation of Microstructure and Tribo-Corrosion Behavior of Microwave Developed Clad on Martensitic Stainless Steel"

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This research focuses mainly on studying the microstructure, consistency, and how well the Nickel chromium alloy powder on SS-420 cladding surfaces resists wear and corrosion when developed using microwave processing. The main aspect of the study involves evaluating how the addition of Nickel particles improves the hardness of cladding surface. Furthermore, this study examines the cladding surface and hardness of the material in tribological conditions. It investigates the microstructure, uniformity, and how well the SS-420 cladding surface with Nickel chromium alloy powder, developed using microwave cladding energy, behaves under tribo-corrosion conditions. The evaluation of the cladding surface's hardness was conducted. To improve the efficiency of the cladding, three microwaves with rated powers of 800, 850, and 900W were utilized for the investigation. The research revealed that microwave hybrid heating (MHH) at a power of 900W was used to develop a cladding of Nickel with chromium alloy powder on martensitic stainless steel. The microstructure of the developed cladding was examined using a scanning electron microscope, and mechanical characterization was completed by using Vickers hardness testing. The analysis showed that the cladding surface exhibited a uniform distribution of NiCrSi particles and a compact, homogeneous microstructure. The results demonstrated that the Nickel and Chromium cladding significantly increased the surface hardness by up to 71.08%, compared to the uncoated SS-420 substrate.

Keywords: Microstructure, microhardness, microwave processing, NiCrSi

ICAMSF-084

Optimizing Tribological Process Parameters in Hybrid Metal Matrix Composites with the Box-Behnken Method

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This study focuses on optimizing tribological process parameters for Hybrid Metal Matrix Composites (HMMCs) using the Box-Behnken method, in a response surface methodology (RSM). The HMMCs were fabricated with Aluminum Alloy 6061 as the base material, reinforced with Boron Carbide (B_4C) for enhanced hardness and Molybdenum Disulfide (MoS_2) for self-lubricating properties. The key tribological parameters considered are Normal load (10 N, 20 N, 40 N), sliding speed (0.5 m/s, 1 m/s, 2 m/s), and temperature (50°C, 100°C, 200°C). They were systematically varied to analyze their effects on

wear rate and friction coefficient, using a pin-on-disk tribometer. A Box-Behnken method was employed to evaluate the wear rate and friction coefficient, interactions between them, and quadratic effects of the considered tribological parameters. The results indicate that temperature and load significantly influence the wear rate while sliding speed has a secondary but notable effect. Regression models were developed to predict wear and friction behavior, with response surface plots used to visualize interactions. Additionally, the wear morphology of worn surfaces is studied. This study highlights the potential of the Box-Behnken methodology in optimizing process parameters with minimal experimental trials while providing detailed insights into material behavior. The findings have implications for improving the performance of HMMCs in high-demand applications such as aerospace, automotive, and defense industries.

Keywords: Hybrid Metal Matrix Composites, Box-Behnken Method, Tribology, Wear Rate, Friction Coefficient.

ICAMSF-085

Optimizing Wear Parameters in Hybrid Metal Matrix Composites via Taguchi Method

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The wear behaviour of Hybrid Metal Matrix Composites (HMMCs) has a major impact on their durability and performance in engineering applications. This study investigates the wear of HMMCs in parent metal Aluminium Alloy 6061 supplemented with Boron Carbide (B4C) and Molybdenum Disulfide (MoS2) particles using a pin-on-disk tribometer. Using an L9 orthogonal array for statistical analysis, the experiments were created with the Taguchi method to improve process parameters such as normal load (10 N, 20 N, 40 N), sliding speed (0.5 m/s, 1.0 m/s, 2.0 m/s), and sliding distance (500 m,1000 m, 2000 m). The findings show that the wear rate is most significantly influenced by the applied force, which is followed by sliding speed and sliding distance. Each parameter's contribution to the wear behaviour was ascertained using the Analysis of Variance (ANOVA). With the addition of B4C having high hardness and MoS2 as self-lubricating qualities, the hybrid composite's reinforcement particle interaction demonstrated enhanced wear resistance. Additionally, the wear morphology of worn surfaces is studied. This study highlights the potential of hybrid composites for applications in the automotive, aerospace, and defence industries, where wear resistance is crucial. The Taguchi method proves to be an effective tool for optimizing process parameters, and reducing experimental trials while ensuring robust results.

Keywords: Hybrid Metal Matrix Composites, Taguchi method, Analysis of Variance, Pin-on-disk, Friction Coefficient.

ICAMSF-087

A Review on Butyl Palmitate as a Fuel Additive for Diesel-Methanol Fuel Blend

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The road transport sector faces significant challenges from global warming and stringent emission regulations, creating a need for cleaner alternatives to conventional diesel fuel. Diesel engines are widely utilized in automotive, maritime, and industrial applications. Yet, concerns over emissions such as nitrogen oxides (NOx), particulate matter (PM), and greenhouse gases highlight the urgency for improved combustion efficiency and emissions reduction. In this review chapter, the performance, combustion, and emission characteristics of butyl palmitate and diesel methanol blend as a diesel engine fuel are presented. Butyl palmitate has become a new promising bio-derived ester additive for diesel-methanol fuel blends. Obtained from butanol and palmitic acid, butyl palmitate increases the efficiency of the fuel because it decreases brake-specific fuel consumption, thus improving the thermal efficiency of the fuel. The oxygenated structure of this additive helps in reducing ignition delay times and makes combustion smoother. The studies show that NOx, PM, CO, and HC levels significantly reduce in diesel-methanol blends if butyl palmitate is added. These studies confirm the sustainability of butyl palmitate as an additive in improving diesel-methanol fuel blend performance and reducing harmful emissions. Investigating butyl palmitate as a fuel additive for diesel-methanol blends is crucial for increasing combustion efficiency, reducing emissions, improving fuel properties, enhancing sustainability, and ensuring cost-effectiveness. Further research will be necessary to assess the long-term impacts on engine performance and optimize blending ratios for wider applications in the transport sector.

Keywords: Feasibility Study, Butyl Palmitate, Fuel Additive, Diesel, Sustainable Transportation.

ICAMSF-089

Sustainable Machining of AZ91-Al_2O_3 Biomedical Composites with Eco-Friendly Coolants and Optimizing Drilling Performance Using and ANN-NSGA II Approach

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The increasing demand for lightweight, sustainable, and corrosion-resistant materials in biomedical applications has driven the development of advanced composite materials. This study explores the

fabrication of AZ91 magnesium alloys reinforced with Al2O3 foam through the environmentally friendly stir casting method. The research emphasizes sustainable machining by investigating the use of eco-friendly coolants such as vegetable oil, liquid nitrogen, and coconut oil—as alternatives to conventional cutting fluids. Drilling performance of the composite was characterized using a Taguchi L18 orthogonal array design, with cutting speed, feed rate, and type of coolant as input factors, each at three levels. Axial thrust force and surface roughness were selected as key response factors to evaluate the machining process. An Artificial Neural Network (ANN) model was developed to predict the drilling responses, while optimization was carried out using a Non-dominated Sorting Genetic Algorithm II (NSGA II) to identify the most sustainable and efficient machining parameters. Influence of drilling parameters and coolants were analyzed and discussed, highlighting their impact on machining performance and the environmental footprint of the process. This study underscores the importance of integrating sustainability into material processing and machining, demonstrating the potential of AZ91-Al_2O_3 composites for biomedical applications. By combining experimental techniques with advanced modeling tools, the research provides a pathway for designing biomaterials that balance performance, environmental responsibility, and cost-effectiveness.

Keywords: AZ91-Al_2O_3 composites, Sustainable machining, Eco-friendly coolants, Artificial Neural Network (ANN), Genetic Algorithm (GA) optimization

ICAMSF-091

Unveiling Trends and Advancement in the Field of Abrasive Waterjet Cutting in Recent Era: A Comprehensive Review

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In the manufacturing sector, especially in the machining division, Abrasive Waterjet Machining (AWJM) find its emergence as a preferable technology for cutting various materials, particularly challenging-to-cut metals. A thorough knowledge of AWJM systems and cutting process parameters is essential to harness the full potential of technology. This review paper presents a comprehensive analysis with the inclusion of previous and recent trends in AWJM applications, aiming to enhance our capabilities of its significance in accurate cutting operations for the fabrication of metal products and other engineering materials. This review contributes to a better understanding of precise cutting operations in metal fabrication sectors by exploring advancements in abrasive waterjet technology. It encompasses the fundamental mechanisms, process parameter improvements, optimization reports, and future research directions, providing valuable insights for researchers in search of the investigation related to the precise machining of different materials and seeking to identify the significance of the machine control variable of AWJM on measurable performance variables. Study also provides reports on material specific study and show the path to researchers in the selection of material for their study. Focus of this article is to include 21st century article and their shortcomings.

Key words: Abrasive Waterjet Machining, Process Parameters, MRR, Surface Roughness

ICAMSF-092

A Novel Approach to Overcome the Melt Pool Dimensions Predictive Capabilities of the Rosenthal Equation at High Linear Energy Density in Selective Laser Melting of Inconel 718 Using Machine Learning

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Melt pools generated in the course of the selective laser melting procedure dictate every major defect, including warping, lack of fusion, crack, and porosity. Therefore, optimizing melt pool sizes for manufacturing quality components is essential. Various research groups developed analytical models based on physics to anticipate melt pool geometries quickly. Nevertheless, the predictive capability of analytical models is constrained by certain assumptions incorporated during their development. The predictive capacities of the Rosenthal equation were investigated in the current study. Rosenthal equation showed quite good accuracy in predicting melt pool dimensions under lower linear energy density printing conditions. However, the prediction capabilities are reduced at high linear energy density process parameter settings. To overcome the limitation of the Rosenthal equation, machine learning methods were applied in the current research. Predictions generated by machine learning (ML) models are not inherently tied to the underlying physical phenomena governing a process; rather, they are contingent upon the quality of the data used during the training process In this study, a dataset was generated using the Rosenthal equation, encompassing various combinations of laser power and scanning speed, spanning from low to high linear energy density. Data points corresponding to lower linear energy densities, where the Rosenthal equation performed well, were used to train machine learning models. The research evaluated three machine learning models: neural network (NN) regression, support vector regression (SVR), and, k-nearest neighbors (KNN) regression. Notably, all three machine learning models outperformed the Rosenthal equation, showcasing higher accuracy and reliability, particularly under high linear energy density printing conditions

Keywords: Metal additive manufacturing, Melt pool dimensions, Analytical equation, Machine learning, Inconel 718, Selective laser melting

ICAMSF-093

Novel wideband FSS based metamaterial structure for MIMO antenna and RAS applications.

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In this paper, a novel FSS based Meta material structure for wideband frequency is proposed. The FSS consists of meta material structure on one sides of the thin dielectric FR4- expoxy substrates of ἐr=4.4

with metal layer thickness of 1.5 mm and the other side of meta material structure is kept continuous. The electromagnetic (EM) analysis of Metamaterial structure is carried out using standard software package and also validated with the experimental results. Initially a square FSS with 2 slit is designed and compared with the square FSS with 4 slit and are verified with the simulation results where 2 slit posses maximum of -23dB of suppression and 4 slit posses band-stop characteristics maximum of -28dB. The Metamaterial structure is further compared with ring shaped structure to improve band pass FSS response with flat-top and sharp roll-off characteristics maximum of -31dB in microwave and millimeter wave frequency regimes. Finally, a prototype of the proposed FSS is designed to possess band-stop characteristics maximum of -59dB and is implemented to suppress frequencies over 2 to 6 GHz frequency. The result shows that the proposed FSS is suitable for the MIMO antenna and RAS applications.

Keywords: Frequency-selective surface (FSS), electromagnetic (EM), Multiple-Input Multiple Output (MIMO), Radar absorbing structures (RAS).

ICAMSF-094

Analysis of Particle Injector Length Using N_2: He

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In our current study, we analyzed three key parameters: impact velocity, particle temperature, and substrate surface temperature. Notably, we examined the influence of pressure, temperature, particle size, and particle velocity across various injector lengths, a novel aspect that has not been previously explored. For our investigation, we selected steel as the substrate material and Titanium as the powder material. The geometric configuration employed was two-dimensional, and the research was conducted using an axisymmetric model. Our findings revealed that at an injector length of 15 mm, the substrate temperature reached its maximum, with the highest impact velocity observed near the substrate compared to other injector lengths. Furthermore, an injector length of 20 mm yielded the most favorable particle temperature under diverse conditions. It's important to note that our simulation encompassed a range of injector lengths.

Keywords: Cold Spray; CFD (Computational Fluid Dynamics) Analysis; Simulation; Particle Injector Length; Impact Velocity, Gas Mixture.

ICAMSF-095

Parametric analysis of wear and surface roughness in 3D printed PLA comparative study of performance of in-house PLA & commercially available PLA filament

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In the rapidly evolving field of additive manufacturing, Polylactic Acid (PLA) remains a popular material due to its biodegradability and ease of use. This study aims to conduct a parametric analysis of wear and surface roughness in 3D printed PLA, comparing the performance of in-house developed PLA filaments with commercially available PLA filament. Various parameters, including printing speed, layer height, and infill density, systematically varied to assess their impact on wear performance and surface quality. Experimental results indicate that in-house developed PLA filaments exhibit performance in terms of wear resistance and surface finish. Detailed statistical analysis reveals significant relationships between the selected parameters and the measured outcomes, providing insights into the optimization of 3D printing processes for enhanced material performance. This comparative study underscores the potential of in-house developed PLA filaments as viable alternatives to commercial PLA filament options, promoting cost-effective and customizable solutions in additive manufacturing applications and unbound the possibilities of synthesizing the PLA filament with PLA waste materials.

Keywords: PLA, Additive manufacturing, Filament, Fused filament fabrication, etc.

ICAMSF-096

Mechanical and Wear Characteristics of Jute Reinforced HDPE/PC Composites

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Natural fibers such as cotton, hemp, coir, jute, bamboo etc., are available in abundance and are being tried as reinforcements in composites for possible use in transport and structural applications. These composites are gaining attention by researchers because of possessing higher strength, wear resistance, biodegradable nature as well as for the economic considerations. This study focuses on the development and investigation of the mechanical and tribological behavior of jute fiber incorporated in high density polyethylene and polycarbonate matrices along with MWCNT nano filler. The composites were prepared by melt mixing method and evaluated for their density, hardness, surface finish, tensile, compression and wear behavior using Density Meter, shore D Durometer, Surface Roughness Tester, Extensometer and Pin on Disc test setup, respectively. From the test results it is observed that the hardness and density of the composites increased with increase in HDPE/PC ratio, whereas surface roughness decreased. As the HDPE/PC proportion in the composites increased from 55/34 to 70/19, the tensile strength, elongation at break and modulus increased by about 27%, 15% and 7%, respectively, whereas compressive strength and modulus decreased by 12% and 11%, respectively. The slide wear loss decreased with increase in

HDPE content from 55 wt.% to 70 wt.% in the composites, whereas the coefficient of friction increased as the load is increased from 20N to 60N. The damaged morphological features of the composites tested for tensile and wear properties were examined and characterized using Scanning Electron Microscopy.
Keywords: Jute Fiber, HDPE/PC, Tensile, Compression, Slide Wear and Friction, Morphology.

ICAMSF-097

Parametric analysis wear and surface roughness of additive manufactured ABS parts from indigenous ABS filament

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By layering on layers of material one after the other, 3D printing, also known as additive manufacturing turns computer models into three-dimensional physical objects. The additive manufacturing process offers notable benefits over conventional manufacturing methods for manufacturing components. These advantages include rapidity, adaptability, variety, affordability, simplicity of handling, chemical resistance, and other attributes. FFF produces intricate designs with little material waste by feeding the filament into a heated print head, which is melted and deposited by the digital model. The current work focuses on the filament extrusion of an in-house manufactured ABS material using a 3Devo extruder to give customized ABS filament and environmental alternatives. The most important factors to consider are the filament's diameter and accuracy over its whole length. This experimental study examines how printing characteristics, such as layer thickness, printing speed, and the number of top solid layers, affect the wear rate and surface quality of printed products. Tests for surface roughness and pin-on-disc compare the tribological characteristics of filaments. The experimental design method of Taguchi (L9) is applied to prepare two independent sets of samples. The experiment findings show that in-house filament performance is better than commercially available filament.

Keywords: FFF, Polymer extrusion, Acrylonitrile Butadiene Styrene (ABS), Tribology, wear

ICAMSF-098

SELF HEALING CONCRETE: A COMPREHENSIVE EXPLORATION OF MECHANISM, BACTERIAL IMPLEMENTATION, AND TECHNIQUES

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Concrete is the homogeneous mixture of cement, fine and coarse aggregate added with water. Also, it's a sustainable material that is frequently utilized in the construction practices due to its affordability and accessibility even though it is prone to fracture development. Concrete is treated with a variety of admixtures to enhance its mechanical properties. However, there is a sharp increase in interest in self-healing materials, especially those with the ability to heal in green and sustainable concrete materials.

Self-healing concrete, also known as self-repairing concrete is one of the novel types of concrete which reduces the need for outside assistance in identifying and fixing internal damage such as cracks. It attributes as smart and sustainable building material used in industrial project. Furthermore, this particular sort of concrete is utilized as an environment friendly and energy efficient material. Due to a lack of exposure and introduction in the civil engineering domain, the self-healing approach gains its popularity in recent era. The present study provides a comprehensive overview of the self-healing mechanisms, methods, influencing factors, and its efficiency. Furthermore, the patterns of advancement in study towards a comprehensive possible utilization of self-healing concrete as an exceptional alternative for conventional concrete are demonstrated.
Keywords: Self-healing concrete; bacterial effect; mechanism of self-healing; construction material; cracks and failure.

ICAMSF-099

Comprehensive Evaluation of Thermochemical Nitriding Methods and Adhesive Characteristics of Coatings on AISI H13 Tool Steel

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The outcomes of nitriding process on AISI H13 steel are compared in this review, with a focus on assessing the nitriding process's efficiency. The adhesion quality of coating materials, which is essential for improving wear resistance, was the primary goal of the study. The findings showed that, in comparison to coatings with low adhesion, those with good adhesion offered significantly improved wear resistance. The finding emphasizes how important it is to maintain the compound layer's integrity in order to protect the dies' longevity and performance. The evaluation also examined developments in coating and plasma nitriding methods for AISI H13 tools throughout the last few decades. A complete overview of current advancements in wear resistance and surface treatment technologies was provided using data from sources like Scopus and tools like Biblioshiny, VOSviewer, SciVal, and Seimat are used to analyse the data. All things considered; the review emphasizes the significance adhesion quality is in determining a coating's resistance to wear. It also highlights how important it is to conduct ongoing research and development in nitriding procedures in order to improve tool performance. This review attempts to direct future research and enhance the use of nitriding technology in AISI H13 tool dies manufacturing by combining the most recent research findings. For researchers and industry experts aiming to enhance nitriding procedures and promote AISI H13 tool steel performance, this thorough investigation provides insightful information with the potential for major improvements in wear resistance and surface treatment. Also discusses the factors important to the efficient use of AISI H13 tools in a variety of industrial applications are highlighted by the developments in plasma nitriding and coating technologies covered in this review.
Keywords: wear resistance, plasma nitriding, AISI H13 tool steel, surface treatment, coatings

ICAMSF-100

A Comparative Study of Copper and Brass Electrodes in Multi-axis Near Dry EDM: Machining Performance and Economic Assessment for IN718

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In the present study, the performance parameters of Multi axis Near-dry EDM process are to be evaluated to achieve the feasibility in machining of Inconel-718 which offers extensive applications in aerospace and gas turbine industries. The low thermal conductivity and high work-hardening characteristics of Inconel-718 make it difficult to machine. Here, the machining is done using in-house developed Multi-axis Near-dry EDM (MX-ND-EDM) setup, in order to select a suitable electrode material for the newly developed process in this study L_9 orthogonal array is applied for experimental investigations with two different electrode materials, namely copper (Cu) and brass (Br). In order to improve the multi response characteristics, including MRR and EWR, on IN718 Taguchi's signal-to-noise ratio is implemented in this work. The best possible combination of control parameters, including current, voltage, and pulse-on-time, has been identified. The results have shown that, for all the current settings, brass electrode provides the highest material removal rate (MRR = 10.21571mm^3/min), followed by copper electrode (MRR = 5.37241 mm^3/min). However, Cu exhibited the lowest electrode wear rate (minimum EWR = 4.582 mm^3/min & maximum EWR = 5.742 mm^3/min), followed by Br electrode (minimum EWR = 12.119 mm^3/min & maximum EWR = 14.075 mm^3/min). Moreover, the surface characteristics of the electrodes after machining were investigated as well.

Keywords: Inconel-718**,** MX-NDEDM, Electrode material, MRR, EWR

ICAMSF-103

Applications, Advancements, and Future Directions of AI and Machine Learning in Tribology

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Artificial intelligence (AI) and machine learning (ML) are at the forefront of transforming tribology by offering powerful capabilities to address its complex, multidisciplinary, and multiscale nature. Tribological processes, which involve intricate interactions across mechanics, thermodynamics, electricity, optics, and magnetics, present challenges that demand sophisticated computational methods for effective modeling and analysis. In this context, the chapter systematically examines how AI and ML are revolutionizing the field, focusing on their applications, recent advancements, and future directions to tackle challenges in analysis, prediction, and system optimization. A structured approach to tribological data is introduced, categorizing it into five distinct types: input data, system-specific information, output data, tribological state information, and derived state information. These categories form the foundation

of an integrative framework that combines advanced AI techniques, such as classification, clustering, and dimensionality reduction, to unify and process diverse datasets. This fusion enables significant progress in predictive modeling, real-time system monitoring, and overall optimization of tribological systems. Central to this chapter is the emergence of "tribo-informatics," an interdisciplinary domain that bridges tribology and informatics. By leveraging AI-driven approaches, including artificial neural networks (ANN), decision trees, random forests, and support vector machines, tribo-informatics addresses critical challenges in predicting essential tribological parameters such as friction coefficients, wear rates, and lubricant film thickness. The chapter presents case studies that illustrate these methods' practical impact and efficiency in solving real-world problems. Exploration extends to AI applications across diverse branches of tribology, including component tribology, extreme tribology, bio-tribology, and green tribology. These discussions highlight AI's transformative role in advancing surface engineering, lubricant formulation, and designing high-performance lubricated systems. To further propel the field, the chapter underscores the need to develop more sophisticated AI tools to enhance surface characterization and optimize tribological system designs. By fostering innovation and encouraging the adoption of cutting-edge AI and ML strategies, this work envisions a data-driven evolution of tribology, setting the stage for transformative advancements in this rapidly progressing discipline.

Keywords: Artificial intelligence, machine learning, tribology, tribo-informatics, surface characterization

ICAMSF-104

Advancements in Pulsed GMAW-Based WAAM for Fabricating High-Quality SS316L Structures with Tailored Properties

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Additive Manufacturing (AM) is revolutionizing the production landscape by enabling the customization of components for specific applications while promoting sustainable, on-demand manufacturing. Among the various AM techniques, Directed Energy Deposition (DED) stands out for its ability to build complex geometries and repair existing components by depositing material layer by layer. Wire Arc Additive Manufacturing (WAAM) is a prominent DED method that employs arc welding technology to fabricate metallic parts with high deposition rates and cost efficiency. Gas Metal Arc Welding (GMAW), a widely used arc welding process, forms the foundation of WAAM, offering versatility and efficiency in creating multilayered metallic structures. An advanced variation of GMAW, known as Pulsed Gas Metal Arc Welding (Pulsed GMAW), further enhances the WAAM process by alternating high and low current phases, improving arc stability, reducing heat input, and minimizing defects. The inclusion of Pulsed GMAW in WAAM for austenitic stainless-steel ASS 316L, a material celebrated for its excellent corrosion resistance and high strength, has yielded promising results. SS316L is extensively used in aerospace, medical, automotive, and marine industries. This study fabricated a multilayered SS316L wall using the Pulsed GMAW-based WAAM technique and analyzed its morphology, microstructure, mechanical and tribological properties. The results revealed a seamless fusion of deposited layers devoid of macroscopic defects, showcasing the efficacy of the WAAM process. Microstructural analysis displayed a dual-phase structure comprising γ-austenite and δ-ferrite, with solidification modes transitioning from fine equiaxed grains at the bottom portion to coarser columnar grains at the top

portions. Grain size increased across the deposition direction with 8.88 µm at the bottom portion and 13.44 µm at the top portion, respectively. Mechanical property evaluations demonstrated a 5.32% decrease in Vickers microhardness from the bottom to the top of the wall, with an average hardness of 177.495 HV. Impact energy followed a similar trend, averaging 85.44 J across the deposition direction. Uniaxial tensile tests showed a decline in yield strength and ultimate tensile strength from the lower to upper sections, averaging 376.33 MPa and 587.33 MPa, respectively, with the bottom portion exhibiting slightly superior strength properties. Tribological performance analysis indicated an increase in the coefficient of friction with higher loads and from the bottom to the top. FESEM analysis showcased that wear mechanisms were predominantly abrasive with partial adhesion. These findings demonstrate the efficacy of Pulsed GMAW-based WAAM in producing high-quality SS316L structures with customized properties for industrial applications.
Keywords: Directed Energy Deposition (DED); Wire Arc Additive Manufacturing (WAAM); Pulsed GMAW; SS316L; Abrasive wear.

ICAMSF-105

The Intersection of Additive Construction and Smart Technologies: A Pathway to Smart Sustainable Built Environment

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With the technological advancement of 3D printing in current scenario, the construction industry is adopting emerging techniques in the prevailing construction practices. The application of Additive Construction or 3D Construction Printing is being adopted on a larger scale with constructive response due to its characteristics of versatility and efficiency. This study aims to present a systematic review on the present condition of adoption of Additive Construction in the building practices. With the assimilation of technological trends of Artificial Intelligence and Internet of Things with Additive Construction, the paper also delves into their applications in enhancing the operation systems and acting the prime catalyst in the construction and working of Smart Structures. The review explores the synergistic probability and challenges associated with the amalgamation of the techniques of Additive Construction, Artificial Intelligence and Internet of Things in construction processes. With the literature survey conducted, the findings highlighted the capability of Additive Construction practices towards customization of structural members with fast prototyping, along with enhancing energy efficiency and thermal comfort with the inclusion of Artificial Intelligence and real–time monitoring of the structures with the application of Internet of Things. The necessity of Additive Construction, its benefits, and drawbacks with applications of AI; and IoT and advancing sustainability in the construction sector is systematically surveyed in the paper.
Keywords: Additive Construction, Artificial Intelligence, Internet of Things, Sustainable Development, Energy Efficiency, Sustainable Built Environment

ICAMSF-106

Enhancing Joint Strength in Dissimilar Al/Mg Alloys through Nanoparticle Reinforcement: A Friction Stir Spot Welding Approach

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The growing demand for lightweight, high-strength materials in aerospace and automotive industries has spurred interest in dissimilar metal joints, with aluminum (Al) and magnesium (Mg) alloys emerging as ideal candidates due to their excellent strength-to-weight ratio. However, joining these metals is challenging due to differences in their thermal and mechanical properties and the formation of brittle intermetallic compounds (IMCs). This study explores the role of aluminium oxide (Al_2O_3) nanoparticles in enhancing friction stir spot welding (FSSW) of AA6061 and AZ31B alloys. The incorporation of Al_2O_3 nanoparticles is expected to refine the weld microstructure, reduce the formation of brittle Al-Mg IMCs, and promote the development of a homogeneous and well-distributed multilayered structure. By modifying the microstructure, the nanoparticles enhance the mechanical performance of the joint, potentially improving strength, ductility, and fatigue resistance. This approach also addresses the critical issue of weld zone brittleness, ensuring more reliable and durable joints. The study further emphasizes the optimization of FSSW process parameters, such as tool rotational speed, dwell time, and plunge depth, to maximize the synergistic effects of Al_2O_3 nanoparticle reinforcement. The findings are anticipated to provide valuable insights into developing advanced dissimilar metal joining techniques, showcasing the multifaceted benefits of nanoparticle incorporation in improving the performance of lightweight structures for high-demand applications.

Keywords: FSSW, Aluminium, Magnesium, Nanoparticles, Alumnium oxide

ICAMSF-107

Effect of composition, normal load, and sliding speed on the dry wear behavior of Stir-Cast Al 2014-SiC Metal Matrix Composites (MMCs)

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Metal Matrix Composites (MMCs) is an engineering solution to enhance the mechanical properties of materials by the addition of a reinforcement media in a suitable matrix. In the current study, the effect of composition, normal load, and sliding speed on the wear behavior of Al 2014–SiC MMCs manufactured by stir-casting has been analyzed. MMCs having three different compositions, with 5%, 10%, and 15% SiC, were fabricated using stir-casting. The effect of three variables - wt% SiC (5%, 10%, and 15%), load (20 N, 35 N, and 50 N), and velocity (1 m/s, 2 m/s, and 3 m/s) on the wear behavior of the material was studied. The wear testing was done on a Pin-on-Disk Tribometer. Taguchi L9 orthogonal array was used to do the statistical analysis followed by ANOVA analysis. The regression equation was used to predict wear for other sets of parameters. From the results, it can be observed that tip velocity has the maximum impact on the wear rate of the material followed by load and wt% SiC. With increasing velocity and

weight percentage SiC, the wear rate decreases. With increasing load, wear rate increases. The worn surfaces were investigated under SEM to identify the wear mechanisms.

Keywords: Taguchi L9, Metal Matrix Composite (MMC), Al-SiC, Wear behavior.

ICAMSF-108

Design and development of micro-SA-ECM experimental setup for improved micro hole fabrication on glass substrate

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The micromachining of borosilicate glass is required due to its applications in fields like microfluidics, optics, and electronics, where its excellent thermal stability, chemical resistance, and optical clarity are crucial for developing precision components and devices. Thus, for this purpose micro spark-assisted electrochemical machining (μSA-ECM) is one of the flexible machining processes for micromachining hard and brittle materials. In this study, the fabrication of micro holes in borosilicate glass substrates has been developed through experimental and optimization studies. A μSA-ECM setup was developed, incorporating electrodes, fixtures, and an effective electrolyte flushing system, to facilitate multiple pilot experiments. In μSA ECM, an electrolyte bath is used along with a tool electrode to generate localized discharges. These discharges melt and vaporize the material at targeted points, enabling high precision. μSA-ECM offers sustainability by minimizing energy consumption and waste, making it an eco-friendly alternative to traditional methods. The ability to machine glass substrates with high precision and minimal damage highlights its importance in advancing microfabrication technologies. Further, RSM methodology is adopted to find the correlation between μSA-ECM parameters and fabricated hole performance and the optimal combination of μSA-ECM parameters for finding high-performance holes in the glass substrate. Through RSM, key performance indicators, such as minimal overcut, reduced surface defects, and improved precision, can be achieved while maintaining process efficiency. Optimized electrical parameters significantly lower energy consumption, promoting sustainability in microfabrication using the μSA ECM process, while maintaining high machining quality.

Keyword: Micro spark-assisted electrochemical machining, RSM, Borosilicate glass, overcut, surface defect

ICAMSF-109

Modeling and optimization of dual-stage electropolishing (DSEP) for additively manufactured SS316L components

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Additive manufacturing manufactures a part by adding materials layer by layer. It is being adopted by various industries, especially biomedical industries, due to its ability to custom and porous design manufacturability. SS316L is a widely used alloy due to its excellent corrosion resistance and strength.

Post-processing of metal additive manufactured components still remains challenging, especially for complex and miniature components. Electropolishing (EP) is a promising technique to mitigate metallic components' surface roughness and enhance corrosion resistance. However, conventional EP is effective when the surface roughness is low. Additively manufactured components, due to various unavoidable circumstances, such as layer-by-layer printing, powder adhesion to the molten pool, rapid heating and cooling, etc., lead to high surface roughness and other defects. These defects are prominent in complex components. In this article, a novel dual stage electropolishing (DSEP) is investigated. In the first stage, high voltage is supplied compared to LCPR (limited current plateau region) to dissolve the defects like partial melts and attached particles, and in the second stage, the potential difference is supplied in the LCPR region for further smoothening. ANOVA analysis is done to optimize the process parameters. Optimization using RSM and ANOVA identified significant parameters, including first stage voltage (V1) and process durations (T1) and (T2). DEP reduced surface roughness by approximately 69% compared to 49% by conventional EP. Also, the EDS analysis showed improved iron and chromium content compared to conventional electropolished parts, manifesting improved corrosion resistance.
Keywords: Dual-stage electropolishing (DSEP), Additive manufacturing, Electropolishing, Process optimization

ICAMSF-110

Role of composition in Al_2O_3/ 314 stainless steel composite coating for enhanced tribological and corrosion performance

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A composite coating is a layer of composite material which is applied to a surface to improve its overall durability, corrosion resistance, wear resistance and heat resistance. These coatings are widely used in various industries like automotive, aerospace, electronics, and manufacturing due to their excellent performance in harsh environments. Steel composites with high Al_2O_3 particle concentrations have great potential, but they still have problems, mostly with adherence at the interface and densification. Directed energy deposition, a variant of additive manufacturing process appears to be one of the suitable alternatives to fabricate the desired coatings. This study investigates the tribological and corrosion properties of the composite coating of Al_2O_3 and SS316 powder prepared by directed energy deposition. Inhouse developed non-pneumatic powder DED system is used to fabricate the coatings. Effect of different compositions in Al_2O_3/ SS316 coating is evaluated by varying the Al_2O_3 content. Four different types of coatings are prepared with varying weight percent of Al_2O_3 and their tribological behavior is analyzed. The corrosion resistance properties of the coating are also analyzed using Tafel curve. The results show that the wear and corrosion resistance of the coating can be significantly improved by applying the composite coating. The presence of more weight percentage of Al_2O_3 content results in the increased hardness and wear resistance which is validated by the friction coefficient and wear loss. Polarization curves indicates that the increased percentage of Al_2O_3 results in the increased corrosion resistance of the composite coating.
Keywords: Directed energy deposition, Tafel curve, Composite coating, wear loss, additve manufacturing

ICAMSF-116

Mechanical properties of nano clay-based hdpe hybrid composites reinforced with bidirectional silk and glass fabrics

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Hybrid composites reinforced with glass and silk fibers have garnered significant attention as effective reinforcements in various matrices, owing to their ability to enhance mechanical and tribological properties. In this study, the combination of silk and glass fibers has been explored within a High-Density Polyethylene (HDPE) matrix, which holds promising applications across engineering industries, particularly in the automotive sector, due to its excellent mechanical properties. The present research focuses on the development and evaluation of silk-glass fiber-reinforced HDPE hybrid composites, fabricated using a hot compression molding process. Two laminate configurations were employed, incorporating nano clay (NC) as a secondary reinforcement at varying concentrations of 0.5, 0.8, and 1.0 wt.%. The composites were characterized for tensile, flexural, compressive, and hardness properties. The results indicate that the tensile strength, compressive strength, and corresponding moduli improved with increasing NC content, with the hybrid composite containing 1.0 wt.% NC demonstrating the most favorable mechanical performance. Notably, the silk and glass fiber ratio was maintained constant across all samples. Furthermore, scanning electron microscopy (SEM) analysis of tensile fracture surfaces provided insights into the damage mechanisms, corroborating the mechanical test data.

Keywords: Hybrid Composites, Silk-Glass Fiber Reinforcement, High-Density Polyethylene (HDPE), Nano Clay (NC), Mechanical Properties.

ICAMSF-117

Enhanced Bismuth based Peroxymonosulfate Activation by rGO/BiVO4 binary composite for Ciprofloxacin Degradation

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Fabrication of binary composites has proven to be a successful strategy for increasing the photocatalytic efficiency of monomer photocatalysts. In the present study, a promising Reduced Graphene Oxide/Bismuth Vanadium Oxide (rGO/$BiVO_4$) composite with exceptional photocatalytic properties has been proposed using a facile hydrothermal technique for direct peroxymonosulfate (PMS) activation

which is effective for quick ciprofloxacin (CIP) removal for wastewater treatment, and fully characterized using XRD, TEM, UV-vis, FTIR, and XPS. The catalyst employs $BiVO_4$ as the main photocatalyst and rGO as an electron acceptor and transporter to degrade CIP in an aquatic environment. The rGO/$BiVO_4$/PMS system demonstrated around 91.86%CIP degradation over 180 minutes of visible light irradiation, which is 1.5 times greater photocatalytic efficiency than rGO/$BiVO_4$ without PMS and three times that of $BiVO_4$ alone. UV-vis and LC-MS techniques were used to investigate potential degradation pathways and 13 degradation products, while TOC analysis was used for evaluating mineralization efficiency. The effects of various reaction parameters, catalyst stability, the key reactive oxygen species, and the primary CIP degradation mechanism were extensively investigated. Additionally, the reactive-species-trapping tests revealed that $^{\bullet}OH$ and e^- were the most important during photocatalytic degradation. This study provides an accurate technique for optimizing the efficiency of Bi-based composites in photocatalytic systems for the degradation of fluoroquinolone antibiotics.

Keywords: Hydrothermal synthesis; Photocatalysis; PMS activation; Ciprofloxacin degradation; Wastewater treatment

ICAMSF-118

Modeling Vibration Characteristics of Laminated Composite Plates: A Neural Network and Multivariable Regression Approach

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This paper outlines the development of predictive models for analyzing the vibrational response of laminated composite plates. Machine learning methodologies, specifically Multiple Linear Regression (MLR) and Artificial Neural Networks (ANN), were utilized to create predictive frameworks. The governing equations are derived using First-Order Shear Deformation Theory, with extensive finite element analyses performed to train and validate the models. Key parameters, including fiber orientations, the ratio of Young's moduli (E1/E2), and the aspect ratio (a/h), were systematically varied. The models demonstrated exceptional predictive accuracy, with a coefficient of determination (R^2) of 0.96 for the test dataset, confirming their ability to precisely forecast the natural frequencies of laminated composite plates. Notably, the finite element analysis results showed excellent agreement with predictions from both MLR and ANN. The innovative integration of machine learning techniques with traditional vibrational analysis frameworks highlights the novelty and utility of these predictive models. By addressing critical design parameters, this approach introduces a new paradigm in structural analysis and optimization. The originality and applicability of the developed framework underscore its potential for patent protection, representing a significant advancement in the field of laminated composite structures.

Keywords: finite element, MLR, ANN, Laminated composite, First order deformation theory, fiber orientation.

ICAMSF-125

Evaluation of cutting speed and surface roughness in WEDM of functionally graded A356 - 10 wt. % Si_3N_4 composite and its optimization for sustainable production

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Functionally Graded Materials (FGMs) are the developing engineering materials characterized by variation in properties along a specific direction and tailored to meet particular applications. Functionally graded aluminium A356 alloy reinforced with silicon nitride (Si_3N_4) was fabricated through a vertical centrifugal casting technique. The main aim of the research work is to investigate the effect of various machining control variables on the Cutting Speed (CS) and Surface Roughness (SR) of the fabricated aluminium FGM subjected to Wire Electrical Discharge Machining (WEDM). The input control variables of this study were Pulse on time (T_{on}), Wire tension (Wt), Wire drum feed (Wdf) and zones from the outer periphery. The cutting experiments were conducted on the WEDM as per the L_{27} orthogonal array using distilled water as a coolant. Taguchi based Grey relational analysis (TGRA) was utilized to study the combined influence of three different variables on the responses. It was found that to maximize the CS and minimize the SR for the specimen cut, the Wt and Wdf should be held at maximum values and T_{on} should be kept at a moderate value. Moreover, the middle zone was elected as the optimum machining location due to the presence of moderate reinforcement particles and the absence of pores, cavities, porosity and cracks. The result revealed that the pulse on time has the major impact (54.07%) on the CS and SR followed by the remaining control variables.

Keyword: Functionally graded materials, Vertical centrifugal casting, Silicon nitride, Wire electrical discharge machining, Cutting speed, Surface roughness, Grey relational analysis.

ICAMSF-127

Fabrication of Z-scheme $CuWO_4$@SnO_2 for the degradation of Malachite green and Congo red dye and investigating the effect of parameters on photocatalytic efficiency

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Z-Scheme heterojunctions combine the unique characteristics of different photocatalysts, offering a possible solution to environmental problems. In this study Copper tungstate doped Stannic oxide ($CuWO_4$@SnO_2) was fabricated by precipitation-hydrothermal method. It showed outstanding photocatalytic activity for the removal of Malachite green and Congo red dye from wastewater in comparison with pure $CuWO_4$ and commercial SnO2 under visible light irradiation using 500 W short arc spherical xenon lamp. The morphological properties of heterojunction were characterized using different methods like XRD, FTIR and TEM, which confirms that both doped and pure nanoparticles are in good proportion with an average crystallite size in the range 8.03-5.01 nm. The elements Cu, W, O and Sn were detected by FESEM-EDX. Scavenger study revealed the number of reactive species which were involved during the degradation mechanism. Photoluminescence (PL) and UV-visible spectroscopy were

investigated for optical properties. Different parameters were studied like pH, catalytic dose, dye concentration and temperature for the investigation of photocatalytic activity. The photodegradation experiments showed that the maximum degradation of malachite green and congo red dye was 80% and 90.5% respectively at pH=5 in 180 min with the dye concentration 10ppm and catalyst dose was 100 ppm. Therefore, this innovative Z-scheme heterojunction approach demonstrates a remarkable promise for different applications and is capable as a multipurpose photocatalyst.

Keywords: Dye degradation; Wastewater treatment; Z-scheme; $CuWO_4$@SnO_2; visible light irradiation

ICAMSF-129

Industry 4.0 Implementation in Different Domains in India: Applications, Trends and Challenges

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Industry 4.0 methodology has gained the popularity due to its limitless opportunities and got implemented in different crucial sectors of the world i.e. manufacturing, construction, textiles, education, healthcare, and more. However, there are some nations who have not fully utilized this contemporary technique into their work culture due to major reform requirements from traditional methods. This research study investigates the industry 4.0 implementation in different areas in Indian market. India is ranked Fifth largest economy of the world, and it becomes imperative to study the work methodology and strategy that major work sector in the country apply. Many practitioners have carried out research on one or another segment of industry, but a holistic literature review was missing that collectively present the areas of Industry 4.0 implementation and the areas where this methodology has not been executed yet and what are the possible reasons. Other than this, the research study also explores the barriers in the way of implementing Industry 4.0.

Keywords: Industry 4.0, Manufacturing, IoT, India, Challenges.

ICAMSF-130

A Comprehensive Review on Nanotechnology in Energy Storage: A Pathway to Higher Efficiency and Stability

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The rapid development of nanotechnology has emerged as a transformative force in the field of energy storage, offering innovative solutions to overcome the limitations of conventional technologies. This paper delves into nanotechnology's application across various energy storage systems, aiming to transcend conventional limitations and explore how nanomaterials and nanostructures enhance lithium-ion batteries, supercapacitors, and hydrogen storage discuss the challenges and future directions in the application of nanotechnology to energy storage. This comprehensive analysis aims to demonstrate

nanotechnology's pivotal role in advancing efficient and stable energy storage, contributing to sustainable energy solutions with future opportunities.

Keywords: Nanotechnology, lithium-ion batteries, supercapacitors, hydrogen storage

ICAMSF-132

Impact of Ultraviolet Radiation on Wear Properties of Additively Manufactured PETG: Experimental Investigation and Analysis

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Additive manufacturing (AM) has gained prominence over traditional production techniques due to its efficiency and material conservation benefits. This study investigates the morphological behavior of PETG (polyethylene terephthalate glycol) material under the influence of ultraviolet (UV) radiation and its subsequent impact on wear properties. Utilizing a Flash Forge 4 Pro FFF printer, PETG samples were fabricated and subjected to a series of wear tests using a Pin-on-Disc Tribometer, in both the conditions with and without UV treatment. The experimental design employed an L9 Taguchi array to optimize parameters including layer thickness, printing speed, and number of top layers. Results indicated that UV exposure significantly deteriorates the wear resistance of PETG, with UV-treated samples exhibiting increased wear compared to untreated ones. The study found that maximum wear in UV-treated PETG was notably higher than in non-UV-treated samples, suggesting that UV exposure accelerates the degradation of PETG material. These findings highlight the need for further research into protective measures against UV degradation to enhance the durability of PETG in practical applications.

Keywords: Additive Manufacturing, Fused Filament Fabrication (FFF), Polyethylene Terephthalate Glycol (PETG), Ultraviolet (UV) Radiation, UV Degradation, etc.

ICAMSF-134

Comparative Evaluation of Potassium Titanate and Steel Fibers as Solid Lubricants in Brake Friction Composites

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In braking systems, the selection of solid lubricants in brake friction composites plays a critical role in ensuring frictional stability, wear resistance, and overall performance under extreme operating conditions. This study conducts a comparative analysis of potassium titanate fibers and steel fibers as solid lubricants in brake pad formulations. Composites were engineered by varying the fiber type and content between 10% and 30%, while other lubricant components, including graphite and MoS_2, were proportionally adjusted. The filler and binder concentrations were held constant to isolate the effects of fiber variation. Phenolic resin-based composites were characterized for physical, chemical, and mechanical properties

following IS 2742 (Part 4) standards. Tribological performance was assessed using a rotating drum setup in accordance with SAE J661 procedures, simulating real-world braking scenarios. Microscopic analysis through scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS) revealed distinct wear mechanisms. Potassium titanate fiber composites demonstrated superior wear resistance and stable frictional behavior due to improved primary and secondary plateau formations on the friction surfaces. In contrast, steel fiber composites exhibited higher wear rates and less consistent friction stability, particularly under high-load conditions. The enhanced performance of potassium titanate fibers was attributed to their intrinsic structural properties, which promote uniform wear and efficient heat dissipation. These findings highlight the potential of potassium titanate fibers as an advanced solid lubricant for next-generation brake friction composites. This research provides valuable insights into optimizing material formulations to achieve improved durability, reliability, and efficiency in braking systems.

Keywords: Potassium Titanate Fiber, Steel Fiber, Brake Friction Composite, Wear Mechanism, Tribological Performance

ICAMSF-135

Taguchi and Machine Learning Integration for Tribological Analysis of PU/ND Nanocomposites

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This study investigates the tribological behavior of thermoplastic polyurethane (PU) modified with nanodiamonds (ND) at concentrations ranging from 0.1 to 0.5 wt.%. The specific wear rate and coefficient of friction (COF) of PU/ND nanocomposites were evaluated using experimental, Taguchi, and machine learning methods. Wear tests were performed using a Pin-on-Disc apparatus under varying conditions, including sliding distances (500–1500 m), applied loads (10–30 N), and sliding speeds (100–300 rpm), designed according to the Taguchi L9 orthogonal array. The experimental results demonstrated that incorporating nanodiamonds (ND) into the PU matrix significantly reduced the specific wear rate. Among the parameters analyzed, Taguchi analysis identified sliding distance as the most critical factor influencing the specific wear rate and the coefficient of friction (COF), followed by applied load, ND content, and sliding speed. Machine learning models further validated and extended the experimental findings, showcasing robust predictive capabilities. The Mean Squared Error (MSE) for wear rate prediction ranged from 0.0005 (1.21%) using Linear Regression to 0.0004 (0.79%) with Random Forest, while for COF, the Linear Regression model yielded an MSE of 0.0161 (5.01%) and the Random Forest model achieved an even lower MSE of 0.0054 (1.68%). Integrating Taguchi methods with machine learning improved the precision of wear mechanism analysis, enabling accurate predictions. This approach provided a robust framework for optimizing the tribological performance of PU-ND composites. It holds great promise for advanced material design and practical applications.

Keywords: Nanodiamond, Tribological Properties, Coefficient of friction, Taguchi, Machine learning

ICAMSF-136

Synergistic effect of B4C and TiB2 on mechanical and tribological properties of hybrid aluminium alloy-based MMC

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Development of lightweight materials has widened their applicability in numerous industries including aviation, automobile, marine etc. Advancement in these fields basically depends on the development of new materials, and advanced processing techniques. Recently, aluminium based metal matrix composites (AMMCs) have been developed by several researchers because of its unique properties like high specific strength and stiffness, sound performance at elevated temperature, and low thermal expansion. However, in the arena of AMMCs, most of the R&D activities are primarily focused on the development of aluminium alloy-based metal matrix composites (AAMMC) in contrast to pure aluminium. Subsequently, incorporation of foreign particles like SiC, TiB2, B4C, and Al2O3 into the aluminium alloy matrix, can alter the properties of AAMMC, and make it suitable for industrial applications. In the present study, a two-step stir-casting process was adopted to cast the composite samples of three distinct weight percentages of B4C and TiB2. Mechanical characterizations like tensile test, compressive test, and micro-hardness were performed as per the ASTM standards. Further, tribological analysis was studied through dry sliding wear test by utilizing pin-on-disc setup. Results show an increase in the tensile strength by reducing the wt.% of TiB2, and increasing the wt.% of B4C. Whereas, enhancement in both compressive strength and hardness is reported by increasing the wt.% of TiB2 and diminishing the wt.% of B4C. An optimum tensile strength, compressive strength and hardness value were observed for the sample with 7 wt.% of TiB2 and 8 wt.% of B4C, 9 wt.% of TiB2 and 6 wt.% of B4C, and 11 wt.% of TiB2 and 4 wt.% of B4C receptively. Additionally, 12% reduction in the coefficient of friction (CoF), and thereby significant enhancement in the wear resistance of Al7075 was obtained for the sample with 11 and 4 wt.% of TiB2 and B4C reinforcement respectively.
Keywords: Al7075 alloy; TiB2; B4C; hybrid MMC; wear resistance

ICAMSF-137

Effect of the mechanical properties of aluminium 2024 beryl composites subjected to severe plastic deformation involving ecap

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The adoption of Aluminum Metal Matrix composites has gained popularity and widespread application in view of their light weight and superior mechanical strength compared to the un reinforced alloy system. Much improved characteristics have been derived based on the adoption of secondary processes such as

rolling, forming, drawing and plastic deformation. In this context, the preparation of Al2024 alloy, containing Beryl particles as reinforcement is envisaged for getting better properties in terms of strength and hardness for structural use in aerospace industry. Further enhancement in properties to strengthen the alloy may be possible by subjecting it to severe plastic deformation, especially Equal Channel Angular Pressing (ECAP) process. The present work focuses on developing Al 2024 alloy composites containing Beryl particles at 6 wt. %, through stir cast method. This is followed by ECAP process carried out in the annealed condition. This facility has been designed and developed in house. Following this, the mechanical properties, involving tensile strength, % elongation & hardness have been evaluated for the ECAP processed Al2024 Beryl samples and the values thus obtained are compared with those derived on samples without Beryl additions. The microstructures of the samples, for key stages of the work, have been recorded. Further, the fracture morphology of ECAP processed samples have been examined and analyzed using SEM/EDAX and correlated with the tensile strength data. The ECAP with pass II processed samples have shown higher tensile strength and hardness as well as good grain refinement in the matrix compared to annealed Al alloy sample.

Keywords: Severe Plastic deformation, Equal Channel Angular Pressing, Tensile Strength, Hardness, Microstructure, SEM, % Elongation, Grain Size.

ICAMSF-138

Synthesis of Cobalt Oxide Nanoparticles: An Eco-friendly Approach

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Green synthesis is a biological method for fabrication of metal nanoparticles (NP's). Though we have physical and chemical methods for fabrication of nanoparticles this method is preferred due to associated benefits such as cost-effective, eco-friendly, clean and high yield production. Cobalt oxide NP's (Co3O4-Nps) was synthesised from the green extract of Syzygium aromaticum leaf, during the process the phytochemicals present in the plants act as the reducing and capping agent. The synthesised NP's were analysed by various characterization techniques like X-ray diffraction (XRD) which confirms high crystallinity with the sharp peaks and scanning electron microscope (SEM) with energy dispersive ray spectroscopy (EDS) confirms the existence of cobalt and oxygen with the grain size 26.5nm and Fourier transform infrared spectroscopy (FTIR) identifies the functional groups present and maximum wavelength of absorption was analysed from UV-Vis spectroscopy. The synthesized Co_3O_4 nanoparticles possess a broad spectrum of applications in fields such as biomedicine, ceramics, gas sensors, dyes, and energy storage devices due to their remarkable properties, including catalytic, chemical, optical, electrical, magnetic, antimicrobial, and antioxidant capabilities. Thus, the anti-bacterial study was done to investigate the zone of inhibition.

Keywords: Green synthesis, Co_3O_4-Nps, Syzygium aromaticum, phytochemicals, antimicrobial and antioxidant

ICAMSF-141

Minimizing the Cutting Fluid Consumption in Turning Operation under Different Machining Environments through Cutting Fluid Optimizer for Reduced Cutting Forces and Surface Roughness

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The excessive consumption of cutting fluids in metal cutting operations presents critical challenges for modern manufacturing industries, encompassing environmental degradation, economic burdens, and health risks. Traditional machining processes rely heavily on cutting fluids for heat management, friction reduction, and precision enhancement, leading to substantial waste generation. Improper disposal of waste fluids contaminates soil and water, posing threats to ecosystems and human health, while production and transportation contribute to a growing carbon footprint. Financially, cutting fluids can account for up to 14% of total manufacturing costs, driven by high purchase, maintenance, and disposal expenses. Present study introduces the Cutting Fluid Optimizer (CFO), a patented, transformative solution designed to address these challenges through real-time regulation of cutting fluid supply. The CFO intelligently adjusts coolant flow based on machining parameters such as temperature, surface roughness, and tool wear, thereby optimizing fluid usage and maintaining machining performance. Experiments were conducted for turning operations on AISI 304 stainless steel using a conventional lathe machine with tungsten carbide tool inserts under flood and Minimum Quantity Lubrication (MQL) conditions with synthetic and vegetable oil-based fluids to evaluate the CFO's performance. The results demonstrated significant benefits: coolant consumption was reduced up to 22.5% during flood condition with synthetic fluids, while MQL applications achieved reduction of approximately 20% and 16% for synthetic and vegetable oil-based fluids, respectively. Surface roughness improved up to 10.76%, and cutting forces were effectively minimized.

ICAMSF-142

Integrated tribological and thermo-structural finite element analysis of silica and alumina coated A356 alloy

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The evaluation of tribological characteristics (coefficient of friction and volumetric wear loss) under combined thermal and structural loading is gaining significant momentum. This study employs Finite Element Analysis (FEA) incorporating both static structural and steady-state thermal modules to assess thermal and tribological characteristics based on experimental data obtained from a pin-on-disc (POD)

tribometer. The FEA focuses on evaluating contact characteristics, including frictional stress, contact pressure, penetration, and sliding status at elevated temperatures. Experimentally, the coefficient of friction and wear loss is determined for samples coated with silica (SiO_2) and alumina (Al_2O_3) and subjected to continuous sliding motion (CSM) against EN31 hardened disc material, with coatings applied using the dip coating technique. Equivalent von Mises stress and heat flux are simulated using ANSYS Workbench, maintaining the boundary conditions consistent with those used during experimental work. Characterization of uncoated, silica-coated, and alumina-coated samples is conducted using Scanning Electron Microscopy (SEM) and Energy Dispersive X-Ray Spectroscopy (EDAX). Results from both experimental and numerical approaches indicate that silica and alumina coatings significantly enhance the tribological and thermal performance of the material at elevated temperatures (100 to 400 $°C$). This research provides valuable insights into improving material performance through advanced coating techniques and comprehensive loading assessments.

Keywords: Surface Engineering, Coatings, Pin on Disc tribometer, Finite element method/analysis, Temperature, Tribological Characteristics, Thermal Characteristics.

ICAMSF-143

Tribological Performance of NaOH-treated Bambusa Balcooa Bamboo Fiber-Reinforced Hybrid Epoxy Composites Enhanced with TiO_2 filler

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This study investigates the tribological performance of NaOH-treated Bambusa Balcooa bamboo fiber-reinforced hybrid epoxy composites, further enhanced with titanium dioxide (TiO_2) filler. The composites were fabricated using the hand layup technique, with varying BF content (0.5 wt%,1 wt%, 1.5 wt%, 2 wt%) and 1 wt% TiO_2, and tested according to ASTM standards for wear properties. The bamboo fibers were chemically treated with sodium hydroxide (NaOH) to improve interfacial bonding with the epoxy matrix, while TiO_2 filler was incorporated to enhance the wear resistance properties of the composites. A series of Fretting wear tests, including wear rate and coefficient of friction measurements, were conducted under varying (20N, 30N, 40N and 50N) loads, sliding speeds, and durations. The results revealed that the 1.5 wt% NaOH treatment bamboo fiber significantly improved the fiber-matrix adhesion, resulting in reduced wear and enhanced load-bearing capacity. The addition of TiO_2 filler further reduced wear rates and friction, demonstrating its effectiveness as a reinforcement agent. Scanning electron microscopy (SEM) was employed to analyze the worn surfaces, providing insights into the wear mechanisms and the synergistic effects of fiber treatment and filler addition. These findings highlight the potential of NaOH-treated Bambusa Balcooa bamboo fiber and TiO_2 enhanced epoxy composites for applications requiring superior wear resistance and durability.

Keywords: NaOH treatment, Bambusa Balcooa bamboo fiber, Hand layup technique, Fretting wear.

ICAMSF-145

Characterization of TiAlN coating on bare and plasma nitrided AISI H13 tool steel

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The coating of TiAlN (1:1 ratio of Ti and Al) has been deposited on bare austenitized and austenitized plasma nitrided AISI H13 hot die tool steel through the physical vapour deposition (PVD) technique. The parameters of the coating process were controlled by using a pulsed power supply which generates the discharge. The surface topography, microstructure, elemental and phase composition, adhesion strength, and residual stresses were evaluated by using an optical profilometer, FESEM/EDS, X-ray diffractometer, Raman Spectroscopy, and VDI-STANDARD 3198. The optical profiler has shown improvement on the coating surface due to the formation of open cavities in plasma-nitrided samples. The hardness of the coating plasma nitrided surface has shown a positive double shift in the value of hardness due to the presence of a duplex layer (48.1HRC) in between the coating and the bare substrate. Adhesion of coating was evaluated by the scratch test with the determination of critical load (Lc1 and Lc2) and coefficient of friction (μc) at critical load under progressive load. It was found that the adhesion of coating deposited over pre-austenitized plasma nitrided samples is on the higher side, with delamination taking place at a higher load than bare-coated samples as shown by the calo images taken for the sample plasma nitrided at 500ºC for 10 hours. The reason for higher adhesion with the substrate is due to the presence of a rough surface of the gradient layer in plasma nitrided samples. In wear tests performed by using SiC balls as counter bodies show significant improvement due to the formation of smooth surface having less coefficient of friction as compared to the high fretting wear caused due to the delamination of coating in bare nitrided samples. Further, the shifting of peaks in the diffraction pattern shows higher residual stresses in samples having very poor surface roughness, causing high grain boundary constraints during coating.

Keywords: Plasma nitriding, scratch resistance, hardness, micrographs, H13 steel, TiAlN coating, and PVD.

ICAMSF-147

Friction and Wear Behaviour of the Developed Tire Rubber

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Rubbers are elastomeric materials under stress and can significantly alter their dimensions before returning to the average load when the deforming load is released. The nanofillers such as graphene and fullerene were incorporated to improve the mechanical characteristics of these rubber composites. The combined impact of the two nanofillers, graphene and fullerene, was investigated in this study. The developed materials are investigated for material characterization using XRD, SEM, EDS, and other tests for morphology elements composition and internal structure of the atoms. Improved mechanical qualities,

including adhesion, hysteresis integrity, rolling resistance, tearing strength, and tensile strength, were obtained. Physiochemical qualities of these composites by focusing on the primary affecting environments of road types, tyre specifications, and ambient conditions, as well as standardizing testing methodologies.

Keywords: Rubber, Nanofillers, XRD, SEM, EDS, Road Characterises.

ICAMSF-149

Thermo-mechanical fatigue behaviour of Ni-based superalloy coated with 8YSZ thermal barrier coatings

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Yttria-Stabilized Zirconia (YSZ) is one of the promising ceramic materials used as thermal barrier coating (TBC) due to its low thermal conductivity, high thermal expansion coefficient, and better chemical resistance. However, the TBCs are often exposed to prolonged high temperature and mechanical stresses initiating catastrophic phase transformation and contribution of oxidation to coating degradation. Therefore, the fatigue behaviour of YSZ based TBC is necessary to minimize the failure of coating system subjected to thermo-mechanical loads. In the present study, the 8% wt. YSZ layer was deposited onto the Inconel 718 Ni-based superalloy along with NiCrAlY bond coat using atmospheric plasma spray with the change in process parameters. The microstructural characterization and damage mechanism of 8YSZ-TBCs under thermo-mechanical loading were investigated at 1200°C. The effect of various process parameters of TBCs on fatigue behaviour were examined. The results showed that the fatigue life of the coated system was reduced with elevated service temperature and increased mechanical loading conditions. Fractographic analysis showed the presence of cracks is more likely to be initiated and propagated with the increase in load. However, optimizing the deposition process parameter of TBCs can lead to a reduction in crack density thereby enhancing fatigue life of the coating.

Keywords: Thermal barrier coatings, Yttria-stabilized zirconia, Thermo-mechanical, Fatigue, Microstructure.

ICAMSF-150

A Review of Corrosion, Characterization, and Mechanical Performance of AA6351-ZrB_2 In Situ Composites at Room Temperature

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The corrosion behaviour and mechanical properties of AA6351 ceramic-matrix composite reinforced with Zirconium Diboride (ZrB_2) particles: A study ZrB_2 was in situ synthesized from Potassium HexaFluorotitanate (K_2ZrF_6) and Potassium TetraFluoroborate (KBF_4) at high temperature. Different characterization methods were used including salt spray corrosion test, Electrochemical Impedance Spectroscopy (EIS) and Scanning Electron Microscope (SEM). The excellent dispersion of ZrB_2 particles in the Al matrix improved its microstructure, mechanical properties and corrosion resistance. The

improvement in mechanical properties was confirmed by hardness, tensile and compression tests. This work demonstrates the utility of AA6351-ZrB_2 composites in applications demanding both high corrosion resistance and high mechanical performance.

Keywords: Potassium HexaFluorotitanate (K_2ZrF_6), Potassium TetraFluoroborate (KBF_4), of AA6351-ZrB_2, Higher corrosion resistance.

ICAMSF-151

A Comprehensive Review on Corrosion Behavior, Characterization, and Mechanical Properties of AA6063-TiC In-Situ Composites at Elevated Temperatures

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Aluminium Matrix Composites (AMCs) is one of the most significant materials introduced in advanced engineering applications due to their advantageous characteristics such as a high strength-to-weight ratio, superior anti-corrosion property and enhanced mechanical performance of AA6063-TiC composites are increasingly noted for their exceptional mechanical and thermal stabilities. This review compiles information on synthesis, characterization and possible applications of AA6063-TiC composites. We discuss the TiC reinforcement's contribution to wear resistance, thermal stability and corrosion behaviour in detail as well as new progress on its fabrication technology. Insights into the key findings through electrochemical, microstructural and mechanical studies are elaborated along with the potential applications of these composites in automotive, aerospace or any other high-performance sectors. The future challenges and research directions are further laid out focusing on both optimization of processing techniques and the creation of hybrid reinforcements.

Keywords: Yttria-Stabilized Zirconia (YSZ), Thermal Barrier Coating (TBC), Thermal Expansion Coefficient.

ICAMSF-153

Comparison Study of Milling Hardened AISI 4340 in Dry and Cryogenic Condition

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Machining processes play a crucial role in manufacturing because they can create precise, complex, and customized parts from a wide variety of materials. This versatility is key for many industries, helping them meet the high standards for quality, performance, and cost-effective. The down milling hardened AISI 4340 steels under dry and liquid nitrogen (LN2) cryogenic cooling was compared at various combinations of machining parameters at high-speed range machining parameters for AISI 4340. Using carbide cutting tools. The range of cutting speeds, V, was between 300-350 m/min, feed rates, f, 0.05-0.1 mm/tooth, and depths of cut, d, 0.1-0.2 mm. The Taguchi L9 method was used to arrange the

experimental runs to minimize the number of experimental runs. The experimental results revealed that a mirror-like surfaces were achieved in cryogenic (0.113-0.241µm) as compared to dry cutting (0.424-0.500µm) conditions, with average surface roughness (Ra) improvement of more than 60%. Radial depth of cut was identified the most influential factors contributing to the Ra, followed by cutting speed and feed rate. At the lowest combination of machining parameters, the tool life was more than triple in cryogenic (37 mins) as compared to in dry cutting (12 mins) conditions with cutting speed was the detrimental factor affecting the tool life followed by the feed rate and radial depth of cut. Industries can utilize the findings from this study to improve the quality of the machined parts, and increase the productivity with significant cost savings.
Keywords: Carbide Cutting Tool; Cryogenic conditions; Dry conditions; AISI 4340; Tool Life; Surface Roughness

ICAMSF-155

FeNb Reinforced A713 Alloy: Enhancing Mechanical and Tribological Performance in Fretting Wear Environments

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This study examines the impact of ferroniobium (FeNb) reinforcement on the mechanical properties and fretting wear resistance of A713 aluminum alloy. Composites were fabricated using electromagnetic stir casting, with varying FeNb contents incorporated into the A713 matrix. Results showed significant improvements in tensile strength, hardness, and wear resistance with increasing FeNb content. The A713-6wt.% FeNb composite demonstrated a 33.18% increase in hardness and a 20.65% increase in tensile strength compared to the base A713 alloy, highlighting the positive effect of FeNb reinforcement. SEM analysis of tensile broken test samples revealed that the A713-6wt.% FeNb composite, which had the highest tensile strength, exhibited smaller dimples and grain refinement due to intermetallic segregation. However, higher FeNb content beyond 6 wt.% led to brittle fracture, characterized by coarse Fe2Nb phases and cracks initiating at phase corners. Fretting wear tests showed that normal load was the primary factor influencing wear behavior for both the matrix alloy and the composite. Worn surfaces displayed typical fretting mechanisms, including abrasive grooves, microcracking, and plowing. The A713-6wt.% FeNb composite showed a significantly lower wear rate (1.803 mm^3/Nm) than pure A713 (2.945 mm^3/Nm), indicating improved wear resistance. These results suggest that A713-FeNb composites, particularly with 6 wt.% FeNb, are ideal for high-performance automotive and engineering applications, offering enhanced mechanical strength and wear resistance in fretting-prone environments.
Keywords: A713 alloy, FeNb, SEM, fretting wear, and mechanical testing.

ICAMSF-156

The Effects of Bambusa vulgaris Stem Ash Particles (BVSAp) on the Tribological Behavior of Stir-Cast A356 Aluminum Alloy Composites

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This study examines how Bambusa vulgaris stem ash particles affect the tribological behavior of stir-cast composites made of A356 aluminum alloy. A356 aluminum alloy is stir cast with 2%, 4%, and 6% Bambusa vulgaris stem ash, an ecologically friendly and cost-effective reinforcing material. Microstructural examination, which includes scanning electron microscopy, was performed on the composites to determine the degree of homogeneity in particle dispersion and interfacial bonding. The pin-on-disc wear testing equipment was utilized in order to evaluate the tribological performance of the material under a range of different loads, sliding distances, and sliding speeds. According to the findings, there were considerable increases in wear resistance with increased stem ash content. These gains are due to the hard ceramic phases that were present in the ash, which had the effect of improving the load-bearing capacity of the composite. As the amount of BSAp reinforcement increases, it is noticed that the coefficient of friction and wear rate decreased. This finding demonstrates that Bambusa vulgaris stem ash has the ability to improve the tribological characteristics of A356 aluminum alloys. Through this work, the practicality of utilizing agricultural waste in advanced composite materials is brought to light. This contributes to the advancement of sustainable development while simultaneously improving the performance of materials for engineering applications.

Keywords: AMMCs, BVSAp, tribological behavior, stir casting

ICAMSF-157

Sustainable Vision: A Conceptual Review of Nanomaterials, Drug Delivery, and Additive Manufacturing for Next-Generation Contact Lenses

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In recent years, there has been a substantial increase in demand for sustainable and multifunctional ophthalmic equipment, driven by the global desire for environmentally responsible technologies and better ocular health solutions. Contact lenses, as critical vision correction products, are experiencing dramatic developments through the use of nanotechnology, medication delivery systems, and environmentally friendly production techniques. This conceptual assessment investigates the creation of next-generation contact lenses to solve major health and environmental issues. A comprehensive search of academic databases, such as PubMed, Scopus, and Web of Science, was done for peer-reviewed publications, patents, and industry reports published between 2015 and 2024. A total of 112 studies were discovered, of which 58 met the inclusion criteria. The admission criteria emphasized advances in material synthesis, medication delivery methods, sophisticated manufacturing, and environmental sustainability. Key issues include the creation of biodegradable hydrogels, the inclusion of graphene

oxide and silver nanoparticles, and the use of additive manufacturing techniques to produce accurate and resource-efficient lenses. The findings indicate tremendous advancement in the sector. Biodegradable hydrogels, recognized for their high oxygen permeability and biocompatibility, are used as a sustainable basis material for contact lenses. The use of nanomaterials, such as graphene oxide and silver nanoparticles, improves lens performance by imparting antibacterial characteristics and increasing mechanical strength. Advanced manufacturing processes, such as 3D printing and in-situ characterisation, allow for more efficient production while maintaining consistency and precision. Furthermore, lifecycle studies show a significant decrease in material waste and energy usage, which aligns with worldwide sustainability targets. Multifunctional contact lenses have also shown medicinal promise via sustained drug delivery systems. Nanocarriers, such as liposomes and micelles, encapsulate medications for targeted and extended release, making them useful in treating glaucoma and dry eye syndrome. These advances not only improve patient compliance but also minimize the requirement for frequent medication delivery, resulting in fewer systemic adverse effects. This research emphasizes the revolutionary potential of incorporating sustainable materials, innovative medication delivery methods, and environmentally friendly production techniques into contact lens development. These technologies, which address both health and environmental issues, mark a huge step forward in vision science and ophthalmology, paving the way for a new era of sustainable and multifunctional ophthalmic equipment.

Keywords: Sustainable contact lenses, nanomaterials, drug delivery systems, additive manufacturing, environmental sustainability.

ICAMSF-158

Experimental investigation on the evolution of phases and mechanical properties in $(Ti_{50}Zr_{50})$-$(Ni_{33}Co_{33}Fe_{33})$ based HEAs developed by equiatomic substitution

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High-entropy alloys (HEAs) are emerging as promising materials due to their exceptional mechanical properties and diverse applications. This study investigates the design and development of HEAs using an equiatomic substitution approach, focusing on the effects of alloying elements on microstructure and mechanical properties. A series of $(Ti_{50}Zr_{50})_x(Fe_{33}Co_{33}Ni_{33})_{100-x}$ HEAs were prepared and characterized. The influence of atomic composition on microstructure and mechanical properties were investigated using X-ray diffraction, SEM-EDS, and micro-hardness testing. This study investigates the prediction of crystal structures in high-entropy alloys (HEAs) using thermophysical parameters (ΔS_{mix}, ΔH_{mix}, Ω, δ, VEC, δ'). The analysis suggests that HEAs with $(Ti_{50}Zr_{50})_x(Fe_{33}Co_{33}Ni_{33})_{100-x}$ composition likely to form a bulk metallic glass. XRD analysis reveals phase formation of intermetallic compounds in $(Ti_{50}Zr_{50})_x(Fe_{33}Co_{33}Ni_{33})_{100-x}$ HEAs. SEM analysis confirms a dual-phase microstructure with dendritic and interdendrite regions, and EDS mapping shows elemental segregation. Vickers microhardness testing reveals a decreasing trend in hardness with decreasing Cobalt content in $(Ti_{50}Zr_{50})_x(Fe_{33}Co_{33}Ni_{33})_{100-x}$ HEAs. The highest hardness (875.76 HV) is observed for the alloy with the most Cobalt, while the lowest (663.16 HV) is for the alloy with the least. Additionally, the HEAs exhibit a superior combination of high hardness and low density compared to conventional materials.

Keywords: High entropy alloy, Phase evolution, Microstructure, Specific hardness, Titanium based alloy.

ICAMSF-159

Synergistic Effects of Surface Texturing and RF Sputtered Ti/TaN Coatings on the Mechanical and Tribological Properties of Ti6Al4V Alloy

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This study investigates the mechanical and tribological behavior of Titanium interlayer Tantalum Nitride (Ti/TaN) coatings deposited on Ti6Al4V alloy substrates. The coatings were deposited using RF magnetron sputtering, with a focus on both smooth substrates and laser-textured surfaces. Surface texturing was achieved using a Nd: YAG laser to create a dimple pattern, with dimples having a diameter of 50 µm and a pitch distance of 200 µm. Ti/TaN nanostructured coatings were developed and evaluated to enhance the protective properties, including mechanical strength and wear resistance, of Ti_6Al_4V alloys. Comprehensive characterization of the coatings was conducted using techniques such as XRD, 3D optical profilometry, FESEM, EDAX, Raman spectroscopy, nanoindentation, and scratch testing to analyze phase composition, microstructure, and mechanical behavior. Wear resistance was assessed with a ball-on-disc tribometer, employing Si_3N_4 as the counter body. The coatings consisted of a ~100 nm Ti layer and a ~400 nm TaN layer, forming a uniform and dense structure. These coatings exhibited excellent adhesion to the substrate, significantly increased hardness (from ~6.08 GPa to 23.57 GPa), and enhanced resistance to plastic deformation, leading to improved bio-tribological performance. The findings revealed that the optimal tribological performance was achieved for coatings deposited to the textured surface, tested across different sliding loads against a Si3N4 ball. Furthermore, wear mechanisms were analyzed for all the tested surfaces. The analysis suggests that combining surface texturing with Ti/TaN coatings on Ti6Al4V alloy can enhance service life and durability, presenting promising prospects for biomedical applications.

Keywords: Ti/TaN coating, RF Magnetron, Surface Texturing, Ti64 alloy, Bio-implants

ICAMSF-160

Effect of various process on antioxidant properties and Physico-chemical properties of Kashmiri haak (KALE)

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Antioxidants play crucial role in protecting body from various oxidative stress which leads to various carcinogenic diseases. Brassicaceae is rich in bioactive phytochemicals which has significant impact on

human health. Kale is the staple food of Kashmir valley it can be consumed as Raw, cooked, fermented and in dried form, it comes in the family Brassica oleracea. Kale is well known for its high nutrition values and bioactive compounds which prevent various degenerative disease. In this investigation antioxidant properties of fresh kale in comparison with the dried and fermented was estimated. The antioxidant properties of kale extracts were investigated by using methods DPPH (2,2-diphenyl-1-picrylhydrazyl), reducing power, lipid peroxidation, FRAP (Ferric Reducing Antioxidant Power) and ABTS (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid).Estimation of physicochemical properties like crude fat, moisture, pH, ascorbic acid, total phenolic content, total carotenoids and total flavonoids of the different extracts was also carried out.Fresh kale showed the highest antioxidant DPPH radical scavenging activity (74.05%), FRAP value (4.8µMFe^{2+}/g), ABTS scavenging activity (79.21%) and Lipid peroxidation inhibition (42.38%). Dried Kale showed the lowest antioxidant activity while as fermented kale recorded an intermediate value for various antioxidant activities. Crude fat content was highest in fermented kale (6.18%) as compared to fresh (1.00%) and dried kale (1.00%). Ascorbic acid content was the highest in fresh kale (24mg/100ml), followed by fermented kale (21mg/100ml) and dried kale (19mg/100ml). This investigation showed that dried Kale has the lowest antioxidant activity while as fermented kale recorded an intermediate value and fresh kale showed abundant amount of antioxidant activities.

Keywords: Kale, Kashmiri haak, Antioxidant activity, Dried kale, Fermented kale.

ICAMSF-161

Investigation on Synergistic Effects of Laser Surface Texturing and TiAlN Coating on the Tribological Properties and Antibacterial Performance of Ti6Al4V Alloy

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Many researchers have sought solutions to increase bioimplants' lifespan by enhancing biomaterials' tribological properties. Recent studies have experimentally investigated improvements in tribological properties through surface modification techniques, such as texturing and coating. This study aims to examine the antibacterial properties of Ti6Al4V alloy using surface texturing and Titanium Aluminium Nitrate (TiAlN) coating treatments. The goal is to enhance the survivability of medical implants by improving both bacterial and wear resistance. The samples were tested with Escherichia coli bacteria, using an amoxicillin disc as a reference antibacterial agent, to identify distinct Zones of Inhibition (ZOI) around the treated samples after a 24-hour incubation period. The surface-modified samples exhibited improved tribological properties when tested using a pin-on-disc sliding tribometer, corroborated by SEM and EDX analyses. Notably, the TiN coating formed over the treated specimens exhibited the largest ZOI, indicating strong antibacterial behaviour. The resulting antibacterial properties of the surface-modified Ti6Al4V alloy suggest its suitability for bioimplants, as it helps prevent biofilm formation.

Keywords: Antibacterial property, zone of inhibition, laser texturing, TiAlN coating, Escherichia coli bacteria.

ICAMSF-162

Experimental Study on the Influence of TiC Addition and Sliding Speed on the Wear Behaviour of Aluminium Matrix Composites

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Due to their remarkable strength, ductility, and superior thermal conductivity, Particulate-Reinforced Aluminium Matrix Composites have emerged as a preferred choice for numerous modern applications. In this study, micro-sized Titanium Carbide (TiC) particles were uniformly distributed within an aluminium matrix using the liquid-state stir casting technique. The composites were prepared with varying TiC content (0%, 3%, 6%, and 9% by weight). The research focused on examining the impact of TiC particle concentration and sliding speed (0.75, 1.5, 2.25, and 3 meters per second) on the wear characteristics of the composites when rubbed against an EN31 steel disc. All experiments were conducted under a constant load of 30 Newtons over a sliding distance of 2000 meters. Findings revealed that increasing TiC content led to higher wear rates, while the coefficient of friction exhibited an opposite trend. Additionally, higher sliding speeds resulted in a reduction in the wear rate, accompanied by an increase in the coefficient of friction. This study highlights the dual influence of TiC reinforcement and sliding speed on the tribological performance of aluminium matrix composites, offering insights for optimizing their use in various industrial applications.

Keywords: Composite; TiC; Sliding Speed; Wear; COF.

ICAMSF-163

Precision Square Ring Force Transducer Development: EN 31 Steel Design for Industrial Applications

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This study focuses on the design and development of a force transducer fabricated from EN 31 grade steel, with a load capacity of 10 kN, and its metrological evaluation in compliance with ISO 376:2011 standards. The transducer was designed using a combination of analytical and computational methodologies and validated through experimental observations. It offers a cost effective and practical alternative to commercial force transducers, achieving a measurement uncertainty of up to 0.10% within its operating range. Factors such as stress, strain, and deflection were rigorously assessed, ensuring reliable performance. The fabricated transducer underwent geometrical and dimensional accuracy verification using a precision coordinate measuring machine (CMM). Metrological characterization revealed an uncertainty within 0.10%, considering parameters such as repeatability, reproducibility, reversibility, interpolation, resolution, and zero offset. This investigation highlights the ease of manufacturing, low cost, and high precision of the transducer, making it ideal for industrial applications.

Keywords: Force transducer; Computational analysis; Metrological characterization; ISO 376:2011; Uncertainty of measurement; Strain gauge, Square Ring Force Transducer (SRFT).

ICAMSF-164

Intelligent optimization of abrasive water jet machining process parameters using evolutionary hybrid PSO-GA algorithms

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Abrasive water jet machining (AWJM) provides precise cutting using high-pressure water, enhancing cost-effectiveness, programming ease, material property retention, and versatility for numerous engineering materials. The present research explores the application of hybrid intelligent methods, combining particle swarm optimization (PSO) and genetic algorithms (GA), to enhance the efficiency of AWJM process parameter optimization. Experimental variables included pressure (150–250 MPa), abrasive mesh size (80–120), flow rate (220–420 g/min), and transverse speed (50–150 m/min). Using a box-behnken response surface methodology, 29 trials evaluated material removal rate (MRR) and kerf taper angle (KTA). The linear regression and analysis of variance were employed to model responses

mathematically, while 3D surface plots explored interaction effects. Finally, hybrid PSO-GA was compared with PSO and GA algorithms using indices like success rate, best solution, standard deviation, and computational time. Results demonstrated that hybrid PSO-GA outperformed PSO and GA in optimizing AWJM process parameters, making it a superior choice.

Keywords: Intelligent optimization; Abrasive water jet machining; Hybrid PSO-GA; Evolutionary algorithms; Ti-6Al-4V alloys

ICAMSF-168

Numerical analysis of fluid flow and heat transfer characteristics in a rectangular serpentine channel cold plate

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The high energy density of a Battery Energy Storage System (BESS) is significantly influenced by the compactness of the battery pack. However, it leads to the accumulation of heat within the battery pack from the cells during the charging and discharging process. Although there are various cooling techniques to remove the generated heat, liquid cooling technology is prominent among them due to its high heat transfer coefficient, its ability to maintain uniform temperatures between the cells, and to operate the battery pack within the optimal temperature range. In order to operate the cold plate of the battery pack with minimal temperature difference and pump work, several heat transfer improvement strategies are still required. In the current study, a rectangular channel shaped cold plate with a hydraulic diameter of 7.7 mm and a channel height of 4.5 mm with a serpentine layout is designed for a 13S1P configuration and tested during discharge conditions by varying the mass flow rate ranging from 0.5 L/min to 3.3 L/min. The simulated results show that the maximum cold plate temperature difference is less than 3 °C when the inlet velocity is greater than 0.4 m/s. The minimal friction factor and maximum Nusselt number are observed when the flow velocity is greater than 0.5 m/s. These results will help in the design of a cold plate for the thermal management system of a battery pack.

Keywords: Rectangular Serpentine Channel, Liquid Cold Plate, Prismatic Lithium-ion Cell, Battery Thermal Management, CFD

ICAMSF-169

Surface Roughness Measurement Using Machine Vision

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Aluminium is a material widely used in manufacturing, across different engineering fields due to its various advantageous properties such as formability, strength, resistance to heat and corrosion as well as flexibility. One interesting application of aluminium is its role in machining Metal Matrix Composites (MMCs). In this study we leverage machine vision technology to assess the roughness of surfaces while

turning MMC composites. We consider factors during the process, including the weight percentage of titanium carbide, feed rate cutting speed and depth of cut. To carry out the experiment we utilize a TiCN Al2O3 tool insert for machining and capture real time images of the machining surfaces using a machine vision system. These images are analyzed using a MATLAB program that extracts grayscale (Ga) values, from images obtained by the machine vision system. Additionally, we also use a stylus probe instrument to evaluate the surface finish of the machined surfaces.

Keywords: Metal Matrix Composite, Surface Finish, Machine Vision, TiCN Al2O3, MATLAB.

ICAMSF-170

Design and Development of Prosthetic Arm Prototype using 3D Printing Technology

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The explosion of 3D printing technology has made the manufacturing and designing of prosthetics much cheaper and easily accessible. This research investigates how the three most common materials, Polylactic Acid (PLA), Acrylonitrile Butadiene Styrene (ABS), and Thermoplastic Polyurethane (TPU), perform for prosthetic purposes. These materials are assessed on important parameters including, but not limited to strength, flexibility, weight, biocompatibility and printability. TTL, most popular due to its printability and environmentally friendly characteristics is tested on low stress components. TCL, which is mainly used for the outer layer because of its enhanced toughness, is considered for limbs prosthesis with more complex structure, while TPE that adds mobility to components like joint is researched on, for its application in very elastic parts. The research study aims at assisting in choosing the right materials when making 3D printed prosthesis as far as functionality and comfort to the user are concerned.

Keywords: 3D printing, selecting materials, printability, prosthetics measurements, Prosthetic Arm.

ICAMSF-171

Influence of high temperature DLC/AlCrN coated grey cast iron on anti-corrosive structural integrity and morphology

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Corrosion and wear of grey cast iron at high temperatures pose significant challenges due to exposure to highly corrosive acidic and basic environments found in exhaust systems, engine cylinder liners, and oil pipes during oil extraction, processing, and engine operation, thereby affecting the lifecycle of these components. Consequently, DLC/AlCrN coatings emerge as a promising surface solution to address these issues. Therefore, this study evaluates the high-temperature corrosion performance of DLC/AlCrN coatings by subjecting them to two temperatures (400°C and 800°C) across 20 heating cycles (1 hour), followed by air quenching. Structural integrity and adhesion to the substrate were assessed through micro-scratch tests, while SEM-EDS, XRD, and Raman spectroscopy provided insights into morphology, elemental composition, phase presence, and molecular interactions. Results indicate that DLC coatings

exhibit robust anticorrosive properties up to 400°C, maintaining structural stability. Beyond this, significant cracking, peeling, and graphitization occur, leading to the formation of thick iron oxide layers at 800°C due to sp^3-to-sp^2 bond transitions and hydrogen loss. AlCrN coatings demonstrate superior thermal stability at 800°C, forming protective Al_2O_3 oxide layers. Mass gain analysis revealed cumulative values of 0.032 g, 0.01 g, and 0.0125 g at 400°C for grey cast iron, DLC, and AlCrN coatings, respectively, and 0.41 g, 0.71 g, and 0.25 g at 800°C. The DLC coating excels at 400°C due to chemical inertness and low permeability, while AlCrN outperforms at 800°C owing to its excellent thermal stability and oxidation resistance due to protective oxide layers (Al_2O_3) at higher temperature. Grey cast iron shows better corrosion resistance than DLC at 800°C due to stable oxide layer formation while DLC completely degrades and loses its protective properties owing complete graphitization. These findings emphasize temperature-specific coating selection for optimal performance in aggressive environments.
Keywords: DLC/AlCrN coating, High temperature, structural integrity, coating morphology

ICAMSF-172

Study of microstructure and wear behaviour of as-built and heat-treated Inconel 718 fabricated by powder bed fusion-laser beam

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Metal additive manufacturing (AM) of Inconel 718 (IN718) produces complex, high-performance parts for aerospace, energy, and automotive applications due to its excellent properties at high-temperature. However, rapid heating and cooling in powder bed fusion laser beam (PBF-LB) process can cause microstructural defects and residual stresses, necessitating heat-treatments to enhance performance. This study investigates the microstructural characteristics and dry wear behavior of IN718 fabricated using PBF LB in both as-built and various heat-treatment conditions. Heat treatments included homogenization heat treatment (HHT) at 1080°C for 1 to 8 hrs, followed by a 1 hr solution heat treatment (SHT) at 980°C to 1140°C, and standard aging heat-tratment (AHT). The results indicate that the initial grain morphology and Laves phase remained largely unchanged after 1-2 hours of HHT at 1080°C. However, a 4-hour HHT resulted in full recrystallization and significant dissolution of the Laves phase. Extending the HHT to 8 hours led to grain growth and the enlargement of carbide precipitates. After heat treatment, the friction coefficient decreased by up to 22% compared to the as-built condition, which was attributed to the formation of γ′ and γ″ phases within the γ-matrix. The findings suggest that these heat treatments significantly enhance the wear resistance of PBF-LB manufactured IN718, making it suitable for high temperature and high-wear applications.
Keywords: Additive manufacturing, Powder bed fusion-laser beam (PBF-LB), Microstructure, Wear behaviour, Heat-treatment

ICAMSF-173

Aluminum Metal Matrix Composites for Automotive Brake Disc Application: Investigation on Tribological and Electrochemical Behavior

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Aluminum Metal Matrix Composites (Al-MMCs) have emerged as a viable solution to the demand for lightweight, high-performance structural materials in the automotive industry. This study investigates the tribological and electrochemical properties of Pressure Assisted Sintering (PAS), a fabrication technique utilizing pressures as high as 350 MPa to produce an Al-MMC disc specimen with a 52 mm diameter. The disc is composed of an Aluminum matrix reinforced with silicon carbide (SiC) and molybdenum disulfide (MoS_2) particles, resulting in a material with exceptional mechanical properties. Two different weight percentages (3% and 10%) of silicon carbide (SiC) with 3% of MoS_2 were incorporated in the fabrication process of the discs, labelled as D1 and D2, respectively. The difference between the disc's theoretical and experimental densities was less than 1%. The Vickers hardness test was utilized to assess the hardness of the Al-MMC disc surfaces. The measured values for D1 and D2 were 107.08 HV0.3 and 123.24 HV0.3, respectively. The wear rate of the discs was determined, revealing that disc D2 exhibited the lowest wear loss with a specific wear rate of 1.36 x 10^{-4} mm^3/Nm. Corrosion studies conducted in a 3.5 wt% NaCl solution indicated that the passive nature of Aluminum changes with the addition of silicon carbide particles, suggesting improved corrosion resistance properties. These enhanced mechanical and electrochemical characteristics offer promising prospects for the utilization of PAS-processed Al-MMCs in the automotive brake disc industry.

Keywords: Aluminum Metal Matrix Composites (Al-MMCs); Pressure Assisted Sintering (PAS); Friction and Wear; Potentiodynamic Polarization Test; SEM.

ICAMSF-174

Mechanistic Rupture of Hard Coating Material

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The comprehensive review explores the behaviour of hard coating rupture on a substrate. A literature survey shows that a crack starts via mode-I of fracture, but it results in mixed modes of rupture with depth of coating. Further, researchers carried out numerical simulations using finite element analysis to get more insight into the behaviour of crack propagation in the hard coating. The researchers reported the effect of coating thickness on the rupture process.

Keywords: Crack Growth, Rupture of Hard Coating, Stress Intensity factor

ICAMSF-175

Optimizing Fatigue Performance of Bearing Steel with c-BN and h-BN Nanoparticles

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Enhancing the fatigue life of engineering materials is essential for prolonging their operational lifespan, particularly in high-stress applications. This research examines the impact of doping SAE52100 steel with cubic boron nitride (c-BN) and hexagonal boron nitride (h BN). The vacuum heat treatment method processes sample pins from materials equivalent to EN31. The experimental design employs the Taguchi method, utilising the L4 orthogonal array to optimise parameters, including the weight percentage of c-BN and h-BN nanoparticles and the temperature of the vacuum heat treatment (VHT). The microhardness analysis indicates an increase from 389 HV0.1 to 791 HV0.1 for a case depth of 50 µm with nanoparticle impregnation. The evaluation of selected factors employs ANOVA and the S/N ratio, revealing that hex boron nitride (h-BN) has a greater impact on microhardness values than the other two factors. Scanning electron microscope (SEM) analysis indicates that the nanoparticles exhibit 22% and 36% atomic weight penetration levels. The 15–18% enhancement in fatigue life for VHT-treated specimens is evidenced by an upward shift in the S-N curve, signifying increased durability. VHT-treated specimens exhibit increased cycles to failure at equivalent stress amplitudes, and for the same lifespan, they can tolerate greater stress levels than untreated specimens. The results demonstrate a notable enhancement in fatigue life resulting from incorporating boron nitride nanoparticles, which is linked to a refined grain structure and improved load distribution.

Keywords: Bearing steel, c-BN and h-BN Nanoparticles, Microhardness, SEM, S-N Curve, Fatigue Life.

ICAMSF-176

Investigation of Tribological and Metallurgical Properties in CP-Ti, Ti-6Al-4V, and Ti-6Al-7Nb Laminates Processed by LSEM

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Titanium is widely used in the biomedical, aerospace, and power plant industries, with various grades tailored for specific applications. This study focuses on fabricating laminates from different titanium grades using the large strain extrusion machining (LSEM) process. A comparative investigation of the dry sliding wear behavior of Grade 2, Grade 5, and Ti-6Al-7Nb laminates was performed. The laminates were produced under dry conditions at different strain rates through a single pass of extrusion machining. The morphology of the samples was analyzed using X-ray diffraction (XRD), energy-dispersive X-ray spectroscopy (EDS), and scanning electron microscopy (SEM). Nano-hardness testing was used to evaluate the hardness of the laminates, while a roughness tester measured surface roughness. The results showed an increase in hardness across all grades compared to the base materials, with the degree of

improvement varying by grade under identical conditions. This increase is attributed to grain refinement caused by severe plastic deformation (SPD) during the process. Furthermore, the analysis of sliding wear behavior revealed enhanced wear resistance in the fabricated laminates compared to the parent materials.
Keywords: Titanium alloys, shear deformation, surface texture, wear, ultrafine-grained

ICAMSF-177

The Impact of Chemical Treatment on the Hydrophobic Properties of Banana Fiber and their compatibility with the composite matrix

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Banana fibers extracted from the pseudostem of the banana plant have attracted considerable attention due to their environmentally friendly characteristics, impressive mechanical strength and affordability. Nevertheless, their natural tendency to absorb water restricts their use in moisture-sensitive applications and polymer composites. This research explores the effects of various chemical treatments aimed at improving the hydrophobicity of banana fibers. Banana (Musa Chinensis) Pseudostem sourced locally were extracted mechanically via Fibre extractor Decorticator machine. Thereafter, Treatments such as alkali, potassium permanganate and tannic acid were applied to alter the extracted fiber surface and their influence on wettability, water absorption and interfacial adhesion in hydrophobic matrices was examined. Various characterization technique such as FTIR and SEM were used to visualize the impact of chemical treatment of banana fibre. Fourier Transform Infrared Spectroscopy (FTIR) is an effective analytical method employed to detect functional groups and chemical bonds in a material through the examination of its infrared absorption spectrum. When applied to the analysis of chemically treated banana fibers, FTIR offers valuable information regarding the surface modifications and structural alterations resulting from the treatments. Scanning Electron Microscopy (SEM) is an advanced imaging method employed to examine the surface structure and microstructural alterations of materials at elevated magnifications. When applied to banana fibers, SEM offers essential information regarding the effects of chemical treatments on the fiber surface, subsequently influencing their effectiveness as reinforcements within composite matrices. The findings received through characterization indicate that these chemical treatments significantly diminish the hydrophilic nature of banana fibers, enhancing their suitability with matrix for advanced composite applications.
Keywords: *Alkali treatment, Hydrophobic, Characterization, cellulose, Morphology.*

ICAMSF-180

Experimental Performance of Cryogenic Treated Cutting Tool (CNMA120408) during Turning Operation of AISI 316 Austenitic Stainless Steel

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This study explores the performance of cryogenically treated cutting tools (CNMA120408) during the turning operation of AISI 316 austenitic stainless steel. AISI 316, known for its superior corrosion resistance and mechanical strength, presents significant challenges in machining due to its work-hardening properties and high cutting forces. Cryogenic treatment of cutting tools has been identified as a potential method to enhance tool life and machining efficiency by improving wear resistance and thermal stability. The research involves a comprehensive analysis of machining parameters, including surface finish, tool wear, and cutting force. Results demonstrate that cryogenic treatment substantially enhances tool performance, contributing to improved productivity and cost efficiency in industrial applications. The findings highlight the potential of cryogenic treatment as a valuable strategy for machining challenging materials like AISI 316 stainless steel.

Keywords: Cryogenic treatment, Cutting tools, AISI 316 stainless steel, Machining efficiency, Tool wear, Surface finish.

ICAMSF-183

Study on the adhesion and adhesion hysteresis of the hydrogel

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The contact behaviour of solid material is governed by the strain rates, externally applied loads, internal adhesive forces and material properties. As the size and stiffness of material decrease, adhesive forces become significant and control the interfacial strength. In current study, a rigid hemispherical acrylic lens is brought into contact with the gelatin hydrogel at different velocities using a linear tribometer. During this, interfacial contact area and the corresponding forces are measured in situ for various gelatin concentrations 10,12 and 15% (weight by volume) at 0.3, 0.5, 1.0 and 1.5 mm/s approach velocities. Experimental data of the adhesion test of loading and unloading is used to determine the energy release rate (G) analytically. G of loading remains almost independent of contact area during loading; however, increase is almost linear with the reduction in contact area during the unloading. G during the loading remains almost independent of the velocity for all the gelatin concentration. However, velocity and gelatin concentration has a positive effect on the G during the unloading. Area under the G-normalized contact area during loading and unloading is used to determine the adhesion hysteresis. Increase in the adhesion hysteresis with the gelatin concentration and velocity follows a power law $\varphi = 0.144c^{1.083}v^{0.2676}$.

Keywords: Gelatin, adhesion, hysteresis, energy release rate, linear tribometer.

ICAMSF-184

Performance of HVOF-sprayed composite coatings against erosion on structural steel

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During the operation of thermal power plants, structural steel components come into contact with conditions that are oxidative and erosive. However, despite the fact that these steels have great structural qualities, they do not have adequate resistance to erosion. Hard coatings are applied to the exposed surfaces of the steel in order to improve their resistance to erosion while still maintaining their structural integrity. Thermal spray coatings can enhance one or more surface attributes of the components. This study employs HVOF thermal spray techniques to deposit NiCrSiBCFe-WC-Co and NiCrSiBCFe-Cr3C2NiCr composite coating powders onto UNS 32760 duplex stainless steel. The primary objective is to enhance the erosion performance of the coating. Erosion behaviour was evaluated for the developed coatings and UNS 32760 duplex stainless steel under impact angles of 30° and 90°, at a velocity of 53 m/s, and a temperature of 400±25°C. Surface morphologies and compositions of both the as-deposited and tested samples were analysed using scanning electron microscopy (SEM) combined with energy dispersive spectroscopy (EDS). Under all tested conditions, the NiCrSiBCFe-WC-Co ceramic coating applied to UNS 32760 duplex stainless steel exhibited superior erosion resistance compared to the NiCrSiBCFe-Cr3C2NiCr coating and the structural steel itself. The improved performance is mainly due to the exceptional hardness of the NiCrSiBCFe-WC-Co coating, resulting from the inclusion of harder phases.

Keywords: HVOF, Thermal spray coatings, NiCrSiBCFe-WC-Co, NiCrSiBCFe-Cr_3C_2NiCr, UNS 32760 duplex stainless steel, erosion performance

ICAMSF-185

Optimized Machining Strategies for Enhanced Surface Quality and Micro Hardness of Magnesium Alloys

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The article made an experimental investigation on the performance of orthogonal turning on an 80 mm circular bar made of AZ61 magnesium alloy. This research work intended to optimize the turning process parameters of in order to achieve better results, such as surface roughness and hardness variation at the micro scale level. On a conventional centre lathe with a power of 2kW medium duty, the turning process is performed by using standard inserts (TN14000 tool). The operation is implemented through discrete variables such as depth of cut (mm), feed rate (mm/rev), and spindle speed (rpm) at three levels as input parameters. The machining process is carried out based on Taguchi-based experimental design with L27 orthogonal array technique. A Surface test instrument (Mitutoyo surf test)- and Micro hardness Tester are deployed to measure the responses of the turning process, such as surface roughness and micro hardness

of the work respectively. MinitabV16 software is used to perform response surface method-based ANOVA at 95% level of confidence to determine the effective machining parameters on the outputs. The results are revealed that the optimization is weigh up by analysis of variance with R-square values of 87.14% and 84.55% for micro hardness and surface quality respectively. The statistical approach showed that the optimized process parameters are as follows, for micro hardness, the middle spindle speed 775 rpm, low feed rate 0.1 mm/rev and low depth of cut 0.4 mm to have minimum variation of micro hardness (A_2 B1C1). For better surface quality, Higher spindle speed 1200 rpm, lower feed rate 0.1mm/rev and lower depth of cut 0.4 mm($A_3B_1C_1$) producing lower surface roughness on the work surface. The feed rate is the most primary factor for both the responses. The combined parameters such that feed rate and depth of cut (B and C) showed better influence on the surface roughness and micro hardness.

Keywords: AZ61, Magnesium Alloy, Response surface method, Surface roughness, Taguchi, Turning.

ICAMSF-186

Forming limit of AA5052-H32 sheet-metal in Single Point Incremental Flange Forming process

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Single Point Incremental Forming is a die-less forming method with low-cost setup and higher formability. The technique has been explored for forming of pyramidal and cylindrical shapes. Moreover, research has been carried out to study forming of asymmetric shapes for various applications including automotive components, aerospace parts and biomedical implants. The implementation of the Single Point Incremental Forming in application where a flange is to be formed on a pre-cut hole involves different deformation mechanism due to presence of the pre-cut hole. The flange forming is carried out in various places of an automotive/aerospace structure. In this work, the Single Point Incremental Forming is implemented to perform cylindrical and square flange forming on AA5052-H32 sheets with 1.5 mm thickness. The square flange forming is carried out using single-stage method to reduce the process time. Least pre-cut hole size which can be formed into a flange without failure is obtained experimentally and by Finite Element Analysis simulations. The limit strain values are obtained by Finite Element Analysis and are validated by experimental results. It has been established that the Fracture Forming Limit line can be obtained by hole flanging tests instead of conventional forming tests. Also, the Finite Element Analysis model has been established which gives Fracture Forming Limit line in close agreement with the strain values obtained by experimental results.

Keywords: Incremental Sheetmetal Forming, Single Point Incremental Forming, Incremental Hole Flanging, Forming Limit Curve, Fracture Forming Limit line

ICAMSF-187

Effect of Laser Hardening Parameters on Friction and Wear Behavior of Grey Cast Iron Rotor for Automotive Brake Disc Application

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This study aims to investigate the influence of laser hardening (LH) input parameters (laser power, scanning speed, beam size, gas flow rate (GFR), and operating distance) on the microstructure, microhardness, and tribological behavior of GCI-LH discs when dry sliding against semi-metallic brake pins. X-ray diffraction techniques were used to examine the phase transformations and grain refinement induced by laser hardening, and microhardness measurements were taken to quantify the surface hardening of LH discs. SEM was utilized to analyze worn LH disc surfaces and generate wear debris to understand the wear mechanism.

Results demonstrated that laser hardening significantly enhanced the surface hardness of GCI, with hardness values increasing with increasing laser power and decreasing scanning speed. Microstructural analysis across the sample depth revealed the formation of a martensitic layer with varying depths and microhardness gradients depending on the laser parameters. Wear tests showed that laser-hardened GCI exhibited significantly lower wear rates than the base GCI. The optimal laser parameters for wear resistance were determined, producing a uniform and deep martensitic layer with minimal residual stresses on the surface. Corrosion tests revealed that laser hardening effectively improved the corrosion resistance of GCI in the NaCl solution. This study provides valuable insights into optimizing laser hardening parameters for enhancing GCI's wear and corrosion resistance. The results significantly affect the design and development of improved wear and corrosion resistance in automotive brake disc applications.

Keywords: Laser Hardening; Friction and Wear; Grey Cast Iron; SEM; Pin-on-Disc Tribometer; Composite Friction Materials.

ICAMSF-188

Wear Debris from Automotive Brake Pad-Disc System: A Critical Review and Future Prospects

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The transport sector is a significant contributor to urban particulate matter (PM) pollution, with emissions originating from both exhaust and non-exhaust processes. Among non-exhaust sources, brake wear debris from automotive brake pad-disc systems represents a significant, yet often underestimated, pollutant. Brake wear emissions include airborne particles that disperse into the atmosphere, and non-airborne particles that deposit on vehicle surfaces, roadways, and surrounding infrastructure. Airborne particles worsen urban air quality issues, while non-airborne debris can re-suspend due to traffic or environmental

factors, contributing to waterway contamination through surface runoff. Brake wear generates particles ranging from nanometers to micrometers, with a significant fraction in the fine particulate range, posing critical health risks. Light-duty vehicles (LDVs) produce 10– 20 mg of brake wear debris per kilometer, whereas heavy-duty vehicles (HDVs) produce 50–80 mg/km. Approximately 40% of this debris becomes airborne particulate matter (PM10), contributing to air pollution. This review synthesizes current knowledge on the mechanisms of brake wear particle generation, the physio-chemical characteristics of emitted debris, and its environmental dispersion and health implications. It also explores how material properties, and operational conditions influence particle formation. By addressing the challenges associated with brake wear emissions, this study underscores the need for advanced materials and innovative design strategies to mitigate their environmental and health impacts.

Keywords: Brake pad-disc system, particulate matter, wear debris, environmental pollution, friction materials.

ICAMSF-189

Comparative Study of Corrosion Behavior of Grey Cast Iron and Laser Cladded AISI 4140 Steel in Simulated Marine Environments for Brake Disc Applications

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This study investigates the corrosion behavior of grey cast iron (GCI) and laser cladded AISI 4140 steels (LCS) in a 3.5 wt% NaCl solution to simulate marine environment effects on brake discs. Electrochemical impedance spectroscopy (EIS) and potentiodynamic polarization (PDP) tests were employed to evaluate corrosion rates and electrochemical mechanisms. Surface characterization techniques, including scanning electron microscopy (SEM), X-ray diffraction (XRD), and Vickers microhardness tests, were performed to assess the morphological, compositional, and mechanical properties of the surfaces before and after corrosion. Vickers microhardness measurements revealed a significant increase in the hardness of LCS compared to the non-cladded GCI surface. Although LCS has a higher chromium percentage than GCI, the results indicated that grey cast iron exhibited higher corrosion resistance compared to AISI 4140 steel in the NaCl solution. This superior performance was attributed to the formation of a more protective and stable corrosion double layer on the grey cast iron surface. SEM analysis revealed a denser and more uniform corrosion product layer on grey cast iron, while AISI 4140 exhibited localized corrosion attack, leading to the formation of cracks. XRD analysis confirmed the presence of iron oxides and hydroxides in the corrosion products of both materials. This study provides valuable insights into the relative corrosion resistance of GCI and LCS in chloride-containing environments, aiding in material selection for automotive brake disc applications. Further research is recommended to investigate the long-term corrosion behavior and the influence of different environmental factors on the corrosion resistance of these materials.

Keywords: Laser Cladding, Electrochemical Impedance Spectroscopy (EIS), Potentiodynamic Polarization (PDP), Vickers Hardness, SEM, XRD.

ICAMSF-190

A Comprehensive Review of Spectacle Frame Materials: Past, Present, and Future Prospects

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The advancement of spectacle frame materials is leading because of consumer's need, advancement in technology, comfortability. Before natural materials such as wood, horn, and bone were used which is having limited functionality which forces advancement of the existing frame materials. Over time, metals, polymers, and composites have introduced new levels of performance, durability, and design versatility. This review analyzed the conventional, recent and upcoming materials to trace the chronological advancements in spectacle frame materials. A comparative analysis performed to understand the properties, applications, and limitations of frame materials. The results show a distinct evolution from basic organic substances to complex polymers like cellulose acetate and high-performance metals like titanium. Recent developments such as memory metals, carbon fiber composites, and bio-based polymers provide both utility and visual requirements. Refurbished and nature friendly materials has decreased the environment pollution and increased the sustainability being a major priority. Spectacle frame materials have evolved to meet the needs of users, combining functionality, comfortability, durability, and sustainability. Emerging developments are likely to integrate smart technologies, nanotechnology for highly customized and multifunctional eyewear. Upcoming advancements also enhance the vision of the users as it incorporates modern technology and provide clarity in vision. These advancements redefine the eyewear industry, balancing technological innovation with healthy ecosystem.

Keywords: Spectacle frame materials, Spectacle frames, material evolution, sustainable design, smart eyewear, advanced materials.

ICAMSF-192

Recent advancement and future scope of spectacle lens material: A review

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From the first glass reading stone in the tenth century to the lenses used today for vision correction, it is expected that titanium dioxide "nanopillars" will be employed to create future planar metalens. The materials used to make spectacle lenses and contact lenses have changed significantly over the past century, from notions conceived by early scientists to those modified for civilian use from military-commissioned innovations. They also hold great potential for the future. Examine the literature on the evolution and development of the materials used in spectacle lenses. With a focus on the most current advancements in material innovation and optical performance, this article discusses recent innovations in spectacle lens materials. Significant advancements have been made in lens durability, lightweight characteristics, and optical clarity within the past ten years. We go over how more recent materials like high-index polymers, photochromic lenses, and lens coatings that improve scratch resistance, lessen glare

and reflections, and block UV radiation coexist with more conventional materials like glass and polycarbonate. We observe noteworthy advancements in hybrid and multifocal lens technology, particularly with regard to aspheric design and the integration of digital features. Notwithstanding these developments, the production of lenses still faces difficulties in striking a balance between material performance, cost-effectiveness, and long-term sustainability. The assessment highlights areas that require further investigation in the future, such as the creation of adaptive lens systems, enhanced lens personalization, and the incorporation of augmented reality features. With improved solutions for a range of user visual needs, these developments have the potential to completely transform the eyeglass market. Insights into the state of the art and areas where more research is expected to have an influence are provided by this abstract, which provides a concise summary of the current developments and future prospects in spectacle lens materials.

Keywords*:* Spectacle Lens Materials, Material Innovation, Optical Performance, High-index polymers, Lens coatings.

ICAMSF-193

A Systematic Review of 3D Printing and Advanced Fabrication Technologies for Nerve Guide Conduits

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The peripheral nervous system finds a vital part in coordinating bodily functions and sensations, and can be severely affected by trauma and neurodegenerative diseases. "Nerve guidance conduits called as (NGCs) are extensively examined as a treatment modal quality for repairing of peripheral nerve damages and its injuries, alongside nerve autografts and allografts. However, the main concerns in establishing their effectiveness for nerve repair and regenerator. The global demand for NGCs is increasing day by day. Various treatments, including surgery and nerve grafting, have addressed these issues case-to-case. However, recent advancements in 3D printing techniques have emerged as promising tools in the field of neural engineering. 3D printing enables the fabrication of complex and customised constructs, offering potential applications in tissue engineering, particularly for functional NGCs. This review paper aims to introduce several fabrication methods or technologies, like solvent casting methods, phase separation methods, freeze drying techniques etc. which incorporate cells, bioactive molecules, and drugs. Developing nerve conduits and printing methods requires a comprehensive understanding of neural architecture, neural cells, different types of injuries, suitable materials, and various factors necessary to enhance the mechanical properties of conduits.

Keywords: 3D printing, NGCs, Peripheral nerve, neural engineering, Nerve conduits.

ICAMSF-194

A Systematic Review on Current Applications of Machine Learning in 3D Printing

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Abstract:3D Printing has been one of the most preferred manufacturing processes by researchers and people in the industry for manufacturing nowadays. 3D Printing also leads to discoveries through physical analysis of the process and the development of novel materials involved. These physical analyses required much time, making it a significant loss point for the critical aspect of Industry 4.0. Machine learning techniques have proven to be a boon for the 3D printing research areas in overcoming these limitations faster. Machine learning is a recent concept that focuses on applying statistical approaches to create intelligent computer systems that can learn from existing information. This study aims to bring out the recent progress made in 3D Printing. Apart from this, five emerging sub-fields have been brought to light, which showcases the impact of technical unions in solving modern problems of errors, extra human efforts, or limitation of resources. One such sub-field is Polymer. Polymers are one of the most commonly used materials in 3D printing, and the properties of polymer materials are responsible for product performance. The other four keys or sub-fields of the newly formed union of 2 techs have been introduced to check, optimize, and design while having access from anywhere around the globe. In the end, a discussion can be found on challenges faced during the Machine Learning (ML) and 3D Printing alliance, like small datasets and issues of transferring resources.

Keywords: 3D Printing, Machine Learning, Polymer, Additive manufacturing, Designing and detection for 3D Printing, cloud

ICAMSF-196

A comprehensive review on the performance characteristics of injection molded polymer nanocomposite gears

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Polymers gears in the past, were restricted to motion transmission in actuators. However, recent advancements in the polymer materials and reinforcements have ensured in developing high performing polymer gears. They are now being used in applications with higher drive power in automotive, chemical, food processing, aerospace and textile industries. Light weight, self lubrication, noiseless operation, corrosion resistance, low inertia and low manufacturing cost are the prime qualities of the polymer gears that made them attractive for the above-mentioned applications. Polymer gears are mass manufactured with dimensional accuracy and proper micro or Nano-reinforcements through injection molding.

Polyoxymethylene (POM), Poly-ether-ether-ketone (PEEK), Acrylonitrile Butadiene Styrene (ABS), Polyamide (PA46& PA66), High-Density Polyethylene (HDPE) have been used as materials for the gear manufacturing. Performance of the injection molded polymer gears are measured by its load bearing capacity and tooth wear under different torque and operational speeds. Micro and Nano size reinforcements can be added to improve the base material performance. Fiber orientation and surface quality limit the performance of the polymer composite gears. Nanomaterials have gained importance as major reinforcements because of their high surface to volume ratio and good adhesion with the polymer even at low volumes. In this regard extensive review on the nanomaterials added to improve the performance of the polymer gears is carried out. Further, review on performance evaluation techniques of polymer nanocomposite gears is also presented.

Keywords: Gear, Polymer nanocomposite, Wear, Nanomaterial

ICAMSF-197

Investigation of Metallurgical and Mechanical Properties in CUSP Magnetic Field Assisted GTAW of DSS 2205

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In this study, experiments were carried out on Duplex Stainless Steel (DSS) 2205 using gas-tungsten arc welding under the influence of external cusp magnetic field (CMF). By using four samarium cobalt permanent magnets, the CMF was generated around the welding arc. The effect of magnetic field on the evolution of metallurgical properties were investigated using numerous techniques. To evaluate the mechanical properties, tensile and Vickers-hardness test were conducted on the weld joint. Experimental results demonstrate that the application of CMF significantly influences heat distribution during welding, leading to enhancement in weldment properties. In CMF assisted welds, bead width and heat affected zone of the weld was reduced by an average of 5%, and 12% as compared to conventional welding. Additionally, the temperature measured 6.5 mm away from the weld centerline exhibited a significant reduction for the same heat input. The additional magnetic field caused a stirring action in the weld pool, which enhanced grain refinement and lead to increase in austenite quantity. Microstructural analysis revealed better distribution of austenite and ferrite phases, and transformation of columnar dendrites to equiaxed dendrites were observed. The application of CMF enhanced the weld tensile strength by an average of 10% and an increase in hardness at heat affected zone was observed. The findings highlight the potential of CUSP magnetic field-assisted welding as an effective technique to improve the weldability and performance of DSS 2205 in demanding industrial applications.

Keywords: Duplex Stainless Steel, Cusp Magnetic Field, Mechanical Characterization, Microstructure, Arc Welding

ICAMSF-198

Tribological Characterization of Al4032 Alloy Lubricated with Biofriendly Diesel with rGO Nanoparticles at Elevated Temperatures: A Taguchi Optimization Approach

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This study investigates the tribological performance of Al4032 alloy under varying conditions using biodiesel as a base lubricant and laboratory synthesized reduced graphene oxide (rGO) nanoparticles as additives. It is worthy to improve the wear resistance of the Al4032 alloy as it finds its application in various fields of engineering. The wear performance can be improved by adding sustainable lubricants which are biofriendly, reliable and long lasting. Thus, Wear behavior was evaluated at different temperatures (30°C, 45°C, and 60°C) through pin-on-disc tests, with wear rate as the primary response. The Taguchi method was employed to optimize experimental parameters (load, temperature, and duration) and minimize wear. Results demonstrate a significant reduction in wear rate with biodiesel lubrication (63.45%) compared to dry running conditions. The addition of rGO nanoparticles to the biodiesel further enhanced wear resistance, achieving a remarkable 93.40% reduction. Analysis revealed load as the most critical factor influencing wear (74-82%), followed by temperature (4-22%). SEM analysis confirmed wear mechanisms such as abrasive wear in lubricated conditions and adhesive wear in dry conditions. This research underscores the importance of understanding wear behavior in Al4032 alloy, particularly in the context of developing sustainable and high-performance lubricants. In this context, rGO nano additives with Biofriendly diesel seems to be promising lubricant to reduce the wear of Al4042 alloy and enhance its operational efficiency and durability.

Keywords: Al4032 Alloy, rGO nano particles, Taguchi, Tribology, Biodiesel.

ICAMSF-199

Physical, mechanical and wear analysis of sisal fiber reinforced dolomite dust-epoxy hybrid composites

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Natural fibers and waste fillers play a vital role in sectors such as medicine, construction and production. The numerous properties exhibited often tend to cultivate curiosity amongst researchers keen on finding eco-friendly solution in the modern age. The present research is to develop a composite filled with sisal fiber (2 wt.%) and dolomite dust (0, 5, 10 and 15 wt.%) as reinforcements. The composites are fabricated by simple hand layup technique and their physical, mechanical and sliding wear properties are examined. It is observed that there is an increase in the density, microhardness, tensile and flexural strength with the

subsequent increase in wt.% of dolomite dust. The sliding wear tests are carried out by Taguchi's L_{16} orthogonal array design. The test results concluded that the filler content and sliding velocity are most substantial factor affecting the specific wear rate (SWR). Artificial Neural Network (ANN) technique is used to analyse the wear response of the fabricated composite samples within and beyond the experimental limit of selected control factors. The predicted results are well aligned with the experimental data. It is also observed that the SWR decreases with the increase in filler content irrespective of sliding velocity and sliding distance. Field-Emission Scanning Electron Microscopy (FE-SEM) is used to analyse the microstructures of the composites before and after wear tests.

Keywords: Sisal fiber, Dolomite Dust, Sliding wear, Microstructure, ANN

ICAMSF-201

Integration Of Renewable Energy Sources Using In Electric Vehicle For Improving Energy Management using FOPID Controller

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The two most sustainable energy sources are Solar and Wind. These Sources are used to develop the Hybrid generating system which is more reliable. This Paper presents the various sustainable energy sources of Hybrid power system. The System consists of two types of renewable energy sources those are Solar PV and Wind integrated with electric vehicle. In this proposed system continuous energy system required storage system, Lead acid batteries are used. PV-FOPID ensures the solar MPPT and WT-FOPID ensures the wind MPPT. The state of charge is showing the efficiency of the Battery. In this system the parameters of the hybrid energy system Voltage, current and power is evaluated using FOPID controller. Control algorithm is using Mat Lab.

Keywords: Hybrid Power System, Solar PV, Renewable Energy, WT-FOPID

ICAMSF-202

Mechanical Properties of chopped rice straw reinforced polymeric composites: An experimental investigation for sustainable natural fibre with water and alkali treated composites

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Since little is known about the hygro-mechanical characteristics of stubble waste fibre composites, their potential is not being fully harnessed. This work describes how the hygro-mechanicial characteristics, contact angle, machinability and morphology of rice stubble fiber-reinforced polymer composites are affected by the pre-treatment with alkali and water 50% and 60% stubble fiber chopped (by weight) reinforced in a polymer matrix was used to create the composite laminates.Pre-treated and untreated composites are compared with regard to their wettability and hygromechanical properties.The composite hygro-mechanical qualities and wettability traits significantly improved as a result of the pre-treatment. With the water and alkali treatments, the tensile strength of composites with a 30% stubble percentage increased by roughly 75% and 43%, respectively. For seven days, the effects of the environmental

conditions are measured at a temperature of 40°C and a relative humidity of 60%. When the results are compared to the untreated specimens, the water-treated specimens are always shown to have better mechanical properties.Following the extended exposure to the environment, a little decrease in the tensile and bending strength was noted.The pre-treatment improved the composite's hydrophobic behavior by increasing the contact angle, according to the contact angle measurements.At 25°C, 50°C, and 75°C, the mass gain analysis is carried out in immersed conditions.The composite's moisture durability was enhanced by the water pretreatment, according to the results, with a mass gain of roughly 10% to 15% less than that of the untreated composite specimens.Experimental under sliding distance (1000–1200 m), sliding speed (4 m/s), and applied force (10 N) were the test parameters under dry sliding conditions. The experimental findings show that adding natural fibers enhanced the polymer matrix's tribological characteristics. To investigate wear mechanism with 60% and 50% fibre weight fraction, the produced composites' worn surfaces were inspected under a scanning electron microscope. Additionally, conventional drilling techniques are used to study the latest advancements in natural fiber reinforced polymer composites. The experimental results revealed that thrust force is highly dependent on drilling parameters where water treated material were found to be the most influential parameter as compared with untreated and alkali treated (2% NaOH) fibre composite board. This indicates that in the years to come, natural fibers a safe, renewable, non-polluting and legal source of fibre will be used extensively in the manufacturing of suistanable composite materials.

Keywords: Rice straw; Mechanical Strength; Hygormechanical durability; Polymer composites; Sustainability; Machinability

ICAMSF-203

Effect of coil current on temperature distribution on extruder in extrusion-based Metal Additive Manufacturing using Induction Heating

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The use of Induction Heating (IH) as an energy source in extrusion-based metal additive manufacturing (EBMAM) is gaining traction due to its advantages of clean, safe, and precise heating, which are already being utilized in other industrial sectors. EBMAM process is similar of fused filament fabrication for polymers by introducing new efficient energy source i.e. induction heating. In this study, extruder surrounded by induction coil is used to melt and deposit aluminium (Al) metal wire filament onto the substrate. The indirect heating of metal filament inside the extruder and then extruding it in semi-molten phase for material deposition is a challenging task that requires special attention. Therefore, it is crucial to identify the temperature profile of the extruder during IH to ensure melting and extrusion of metal wire. The induction heating parameters, such as current and frequency, are crucial parameters and should be carefully chosen to obtain the desired temperature distribution on the extruder. In this study, to investigate the thermal behaviour of the extruder, an electromagnetic-thermal coupling model has been used for simulation. In which, due to the symmetrical nature of the problem statement, a 2D axisymmetric geometric model of the extruder with an induction coil has been used for simulation using the induction heating module of the COMSOL Multiphysics software. The simulation study analysed the temperature distribution by varying current values from 200 Amperes to 300 Amperes with a constant frequency of 55

kHz during IH of the extruder. Through simulation findings, it has been observed that temperature achieved on extruder outer surface is 650 °C, whereas inner surface temperature is 610 °C at that instant. i.e., a 40 °C temperature drop has been observed across the extruder cylindrical wall from 8 mm outer radius to the 0.9 mm inner radius. The obtained temperature at inner surface is sufficient to melt aluminium metal filament, for which melting range is 575 °C to 635 °C under the boundary condition of 200 A current. Whereas at higher current value, it has been observed that a higher temperature drop has been observed which is around 68 °C and 99 °C in case of 250 A and 300 A current respectively; therefore, it should be preferable to print aluminium material through a novel experimental setup using 200 A current. Further simulation results help to develop the novel experimental setup in metal Fused Filament Fabrication (mFFF) lab to develop the Aluminum material in desired form/geometry using Al filament.

Keywords: Induction Heating, Metal Additive Manufacturing, Aluminum, COMSOL Multiphysics.

ICAMSF-204

The Role of Graphene in Tribology: Advances in Polymer and Metal Matrix Composites

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Graphene and its derivatives have emerged as transformative materials in tribology, offering supreme properties such as low friction, exceptional stiffness, chemical inertness, and high thermal conductivity. Substantial enhancements in wear resistance, lubrication, and overall tribological performance have been achieved by integrating graphene into both polymer and metal matrix composites, which provide valuable applications in aerospace, automotive, and manufacturing industries. However, the commercialization of graphene-based composites has been hindered by issues such as scalability, weak interfacial adhesion, and poor dispersion. This review systematically evaluates recent advances in graphene-reinforced composites, with a focus on their mechanical and tribological properties. It's interesting to consider that while graphene's two-dimensional structure allows heat dissipation and self-lubrication, how layer thickness, functionalization, and graphene dispersion affect composite performance remains largely unexplored. Additionally, graphene's potential to improve environmental sustainability through energy savings and lightweight characteristics highlights its growing significance in energy-efficient systems and green manufacturing. The proposed novel insights aim to address existing gaps by investigating improved functionalization strategies that enhance interfacial bonding, creating hybrid graphene composites with specific applications, and understanding the composites' long-term stability under various operating conditions. Enhancing the incorporation of graphene into polymer matrices could lead to innovations in biomedical tribology, specifically in the areas of joint replacement and bio-lubrication.

Keywords: Wear, Friction, Graphene, Polymer matrix, Metal matrix, Mechanical Properties.

ICAMSF-205

Durable Self-Cleaning and Self-Heating Superhydrophobic Coatings Based on Reduced Graphene Oxide Composites

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The practical use of superhydrophobic coatings is significantly limited due to their complex fabrication processes and the fragility of their hierarchical surface structures. In this study, a robust superhydrophobic coating with a double-layer structure was developed through a simple and cost-effective approach via spray coating. The coating consists of a non-wettable layer made from rGO nanoparticles and PTFE; epoxy resin adhered to a binder resin layer on a carbon fiber-reinforced composite substrate. With the addition of 5% PTFE, which has low surface energy, the rGO nanoparticles at concentrations of 0.3%, 0.5%, 0.7%, 1%, and 1.5% were effectively fixed after curing and cross-linking with the adhesive layer. When the rGO content was between 0.3 wt. % to 1 wt. % with 5 wt. % PTFE, the WCA of the coating increased from 108° to 151°. Mechanical durability tests showed that the coating retained its highly hydrophobicity even after 100 cycles of friction or 50 cycles of tape peeling using 3M tape. Moreover, the coating exhibited self-cleaning properties against graphite powder. Additionally, the rGO-coated surface demonstrated outstanding Joule-heating performance, reaching a temperature of 75 °C under a 30V direct voltage with just 1 wt% rGO content. This combination of a rough surface layer and an adhesive binder layer will provide a promising solution to the practical application of artificial superhydrophobic coatings.

Keywords: reduced graphene oxide, superhydrophobic surface, durability, self – cleaning and self-heating

ICAMSF-207

Oxidised cellulose nanofibres from coir waste for methylene blue dye removal from aqueous solutions

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Rising global concerns over water pollution have increased the valorisation of agricultural wastes as a sustainable solution to minimize the negative impacts of these wastes on the environment. In this work, oxidised cellulose nanofibres were successfully prepared from coir waste via a two-step chemical process involving microwave assisted bleaching and ammonium persulphate oxidation. The oxidised cellulose nanofibre was employed as an adsorbent for the removal of methylene blue dye from aqueous solutions. Well separated needle-like morphology was obtained with 17.5 nm in diameter. The presence of carboxylate groups on the surface of cellulose nanofibres as confirmed by Fourier transform infrared spectroscopy provide negative charges which aid in adsorbing the cationic dye molecules. It was observed that as the ammonium persulphate concentration increased, the degree of oxidation decreased and crystallinity increased inhibiting any further oxidation. The study evaluated the dye removal efficiency of oxidised CNF under different conditions, including variations in pH, dye concentration, dosage, and

reaction time. The adsorption process was well described by Langmuir isotherm model and pseudo second order model with a maximum adsorption capacity of 270 mg/g. Hence, the results proved that the oxidised cellulose nanofibres could be utilised as a potential sustainable adsorbent for the remediation of methylene blue dye from aqueous solution.

Keywords: Cellulose nanofibers, ammonium persulphate, coir, methylene blue, oxidised cellulose nanofibres

ICAMSF-209

Drilling studies on the effect of cryogenic treatment and coated tool on the surface quality of AA7075/Al_2O_3 syntactic foam-based composite

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In this study, AA7075/Al_2O_3 syntactic foam composites were fabricated using the stir casting process, and their machinability in drilling operations was systematically evaluated. The investigation considered both continuous parameters such as spindle speed and feed rate along with categorical factors, including tool type and coolant application. A Ti-AlN-coated carbide tool and liquid nitrogen coolant were utilized during the drilling experiments, which were designed using Taguchi's L16 orthogonal array. The study primarily focused on assessing axial thrust force and surface roughness to evaluate the drilling performance of the developed composite. To optimize the drilling parameters, a Multi-Criteria Decision-Making (MCDM) approach was employed, integrating the Analytic Hierarchy Process (AHP) for weight assignment and the Combined Compromise Solution (CoCoSo) method for ranking-based decision-making. The AHP method was used to systematically determine the relative importance of performance indicators, while CoCoSo facilitated the ranking of machining parameter combinations to identify the optimal drilling conditions. The results indicate that coolant application had a more substantial impact on surface quality compared to tool coating. Additionally, the interaction between feed rate and coolant significantly influenced surface roughness, emphasizing the necessity of optimizing machining parameters for improved surface integrity in AA7075/Al_2O_3 syntactic foam composites. The proposed AHP-CoCoSo approach proved to be an effective decision-making framework for multi-objective optimization in machining studies, enabling a balanced trade-off between axial thrust force and surface roughness.

Keywords: AA7075, Al_2O_3 foam, Stir casting, Drilling, Liquid Nitrogen, surface roughness, Optimization

ICAMSF-210

Tribological Optimization of AZ91/TiB_2 Magnesium Matrix Composites Using Stacked Ensemble Learning and Bayesian Optimization

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This study investigates the tribological performance of AZ91 magnesium matrix composites reinforced with TiB_2 particles, synthesized using the stir casting technique. TiB_2 reinforcements were incorporated at 2, 4, 6, and 8 wt.% to enhance wear resistance. The wear behavior was systematically analyzed by varying normal load, sliding speed, and reinforcement content, structured through a Taguchi L18 orthogonal array. A Stacked Ensemble Learning (SEL) model, integrating multiple regression architectures, was employed to predict wear rate and friction coefficient with high accuracy, ensuring robust generalization across varying test conditions. Additionally, Bayesian Optimization Algorithm was implemented for multi-objective optimization (MOO), effectively balancing wear resistance and mechanical stability while leveraging probabilistic modeling for improved search efficiency. The optimized results indicate that 6 wt.% TiB_2, under moderate loading conditions and controlled sliding speeds, yields significant improvements in wear resistance due to the formation of a load bearing tribolayer and increased dislocation density induced by TiB_2 particulates. The presence of TiB_2 acts as a solid lubricant and hinders the plastic deformation of the soft AZ91 matrix, leading to reduced material loss during sliding contact. Comparative validation between experimental and predicted results confirms the model's reliability, achieving a prediction error of <5%. The proposed hybrid methodology integrating predictive analytics with Bayesian-driven optimization presents a computationally efficient and experimentally validated framework for designing high-performance Mg-based composites with superior tribological properties. This approach advances the development of lightweight structural materials, reinforcing their applicability in aerospace, biomedical, and automotive sectors.

Keywords: AZ91 Magnesium Matrix Composite, TiB_2 Reinforcement, Wear Behavior, Stacked Ensemble Learning, Bayesian Optimization

ICAMSF-212

Wear Performance and Optimization of hBN-Modified AZ91/TiB_2 Magnesium Composites Under Dry Sliding Conditions

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The present study focuses on the development and tribological evaluation of AZ91 magnesium matrix composites reinforced with TiB_2 and hexagonal boron nitride (hBN) nanoparticles. The TiB_2 content was fixed at 6 wt%, while hBN was varied at 0.5, 1, 1.5, and 2 wt.% to examine its influence on wear performance. The composites were fabricated using the stir casting technique, followed by tribological testing under dry sliding conditions. The wear experiments were designed based on an L16 Taguchi orthogonal array, incorporating variations in normal load, sliding speed, and sliding distance. To establish predictive insights, Gradient Boosting Regression (GBR) was employed to estimate wear rate and friction coefficient, effectively capturing nonlinear dependencies between input parameters. Further, Multi-Objective Particle Swarm Optimization (MOPSO) was applied to determine the optimal combination of reinforcement content and test conditions for minimizing wear and friction while maintaining mechanical integrity. The results indicate that the hybrid composite with optimized hBN content exhibits enhanced wear resistance, attributed to the combined effects of solid lubrication and microstructural reinforcement. The self-lubricating nature of hBN reduces frictional heating and surface damage, whereas TiB_2 contributes to load-bearing capability and matrix strengthening. Experimental validation confirmed a strong correlation between predicted and observed values, demonstrating the reliability of the proposed modeling approach. This study highlights the potential of machine learning-driven optimization in designing advanced Mg-based composites for applications in aerospace, biomedical, and automotive industries, where high wear resistance and lightweight materials are critical.

Keywords: Magnesium Matrix Composites, Hexagonal Boron Nitride (hBN), Tribological Performance, Gradient Boosting Regression (GBR), Multi-Objective Particle Swarm Optimization (MOPSO)

ICAMSF-213

Development of 3D-Printable Titanium Dioxide (TiO2) filled-ASA Polymer Nanocomposite (PNCs) Feedstock for Fused Filament Fabrication (FFF)

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3D-printed polymeric products often suffer performance degradation when exposed to prolonged outdoor environmental conditions such as sunlight, moisture, temperature, and chemicals. To address this issue, the incorporation of nanomaterials into polymer matrices has emerged as an effective strategy, offering enhanced shielding capabilities against outdoor environmental factors. This research focuses on developing an 3D-printable polymer nanocomposites (PNCs) with improved UV, thermal, and moisture shielding capabilities by integrating titanium dioxide (TiO2) nanofillers (NFs) into an acrylonitrile-styrene-acrylate (ASA) polymer matrix. The TiO2-filled ASA PNCs were prepared using solution+melt blending combined approach, followed by filament feedstock production through melt compounding for fused filament fabrication (FFF). The study aimed to investigate the effect of varying the filler ratios (0.5, 1.0, 1.5, 2.0, and 4.0wt%) on the ASA polymer matrix and conducted characterizations to identify the optimal filler ratio for feedstock development to enhance mechanical and weathering performance of ASA for outdoor applications. UV-Vis spectroscopy and rheological (MFI) analyses were performed on the developed PNC filaments to evaluate the effect of the varying TiO_2 NFs filler ratios on the polymeric matrix. The results showed that addition of the filler up to 1wt% significantly enhanced UV-absorbing capabilities (up to 4%) and improved flow processability for FFF, which contributed to better weather resistance properties. Subsequently, mechanical (tensile, flexural, impact, and hardness) and microstructural (SEM) analyses were conducted on the 3D-printed specimens to evaluate strength enhancement and interfacial behavior due to the addition of the NFs. The results demonstrated that filler loadings of 0.5 and 1 wt% provided higher strength compared to neat ASA and exhibited better interfacial adhesion, which was beneficial for property enhancement. Therefore, the TiO_2-filled ASA PNC filaments could serve as potential alternatives for use as shielding materials in 3D printing, enabling the manufacture of robust, customizable products for outdoor applications with superior performance under challenging environmental conditions.

Keywords: 3D printing; Additive Manufacturing (AM); Fused Filament Fabrication (FFF); Polymer Nanocomposites (PNCs); Acrylonitrile Styrene Acrylate (ASA); Titanium Dioxide.

ICAMSF-215

A Comparative Study of Mechanical Properties and Microstructural Behaviour of CMT and GMAW Welded Ferritic Carbon Steel AISI 1080 (UNS G10800) Joints

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When ferritic carbon steels like AISI 1080 are joined, rough grains are formed in the fusion zone, reducing ductility and toughness. To address the issues associated with the joining of AISI 1080 Carbon

Steel, a controlled and well-established welding process is needed. In this study, the metal is welded by using a low-heat input CMT welding process and compared with the advanced and well-established robotic GMAW welding process to get the optimum solution to weld a Ferritic AISI 1080 Carbon Steel (UNS G10800). Tensile strength (TS) analysis reveals that, in comparison to the base metal (BM), and heat-affected zone (HAZ), the weld metal (WM) exhibits the highest TS. The results of hardness testing showed that the base metal had the lowest hardness of 167 HV, which is 75.69% of the weld metal hardness. For both CMT and GMAW welding, micrographs were taken from the WM, HAZ, and BM and examined as part of the microstructural investigation. The result highlights the change in the mechanical and microstructural properties of the material during welding.

Keywords: Robotic CMT, robotic GMAW, FSS, TS, YS, Microstructure, Microhardness.

ICAMSF-216

Synthesis of medium and high-entropy oxides from mixed oxides and metals through high-temperature sintering

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The synthesis of medium- and high-entropy oxides (MHEOs and HEOs) offers exciting possibilities for advanced materials with superior thermal and mechanical properties. This study focuses on the development of entropy-stabilized oxides using a combination of MgO, CuO, ZnO (pure oxides), and Fe and Ni (pure metals) as starting materials. The components were mixed in equimolar proportions and subjected to a sintering process at 1000°C for 5 hours to promote solid-state diffusion and phase stabilization. X-ray diffraction (XRD) confirmed the formation of a stable single-phase structure with uniform distribution of cations across the lattice, indicative of high configurational entropy. Scanning electron microscopy (SEM) revealed a homogeneous microstructure with reduced porosity, which contributes to enhanced mechanical strength. The resulting oxides exhibited remarkable thermal stability, excellent resistance to oxidation, and improved hardness, making them suitable for extreme environment applications such as thermal barrier coatings, catalysis, and energy storage. This work demonstrates the successful synthesis of MHEOs and HEOs through a combination of pure oxides and metals, providing insights into the role of composition and sintering parameters in tailoring material properties for advanced applications.

Keywords: Medium entropy oxides, High entropy oxides, Sintering, extreme environments

ICAMSF-218

Design and Development of a Prosthetic Hand Using Fused Deposition Modeling

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This study explores the design and development of a cost-effective, lightweight, and functional prosthetic hand using 3D printing technology. As per statistics, only 5% of amputees in India get access to

prosthetics. The high cost and limited accessibility of traditional prosthetic hands pose significant challenges for individuals requiring such aid. This study identifies 3D printing as a transformative solution, which is also affordable, has customization potential, and can create complex design. The key materials focused on this project include PLA and PETG. Their strengths, durability, and aesthetics were evaluated, with PLA carbon fiber, ultimately being selected as the optimal material. This project also employed advanced tools like 3D scanning, modelling software, and additive manufacturing techniques to create prototypes that were rigorously tested for using and performance. By integrating user feedback and healthcare insights, the prosthetic hand can be met with ergonomic and functional needs. This study demonstrates how 3D printing can be used to revolutionize prosthetic design and make it accessible and affordable for a broader population. Thus, the findings also provide a foundation for future innovation, including the integration of sensors, which has motion capabilities, contributing to improved quality of life for amputees in India and worldwide. This prosthetic hand is made by keeping in mind cost reduction, weight reduction and basic functionality of holding.
Keywords: PLA, PETG, Additive Manufacturing, 3D Scanning.

ICAMSF-219

Biomass Conversion Technologies for Clean Energy: A Comprehensive Overview

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By using organic matter from forestry, agriculture, and industrial waste, biomass energy provides an alternative to fossil fuels and is acknowledged as a crucial part of sustainable energy systems. Notwithstanding developments, current assessments frequently fall short in providing thorough coverage of new conversion methods and measurable performance indicators. In order to fill in the gaps in earlier research, this study summarises developments in biomass conversion technology, assesses the effects on the environment and the economy, and pinpoints strategies for sustainable and scalable implementation. The following keywords were used to gather data from 50 academic publications published between 2020 and 2024: "biomass conversion," "pyrolysis," "gasification," and "hydrothermal processing." Studies comparing technological efficiency, emissions, and economic viability were included in the review. Statistical insights and comparative tables were used to present the findings. Under ideal circumstances, the efficiencies of gasification and pyrolysis can exceed 60%, demonstrating their considerable potential. For wet biomass, hydrothermal processing has special benefits. Scalability and emission control are still major obstacles, though. This paper highlights new uses for microbial fuel cells and AI-driven process optimisations, integrating current developments in a unique way. It offers doable suggestions for handling operations scale and feedstock fluctuation.
Keywords: Biomass energy, pyrolysis, gasification, hydrothermal processing, renewable energy.

ICAMSF-220

Investigation of Mechanical Properties of PETG Material by Experimental and Numerical Method

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This study gives a comparative analysis of mechanical properties for polyethylene terephthalate glycol (PETG) relative to other prevalent 3D printing materials, using experimental and numerical methods. This study follows a two-fold investigation method: initially substantiating the tensile and flexural properties of PETG through pragmatic laboratory tests and subsequently confirming these findings through Finite Element Analysis (FEA). This methodology supports the reliability of the experimental data along with providing a strong framework for assessing the material properties in simulated environments. This comparative analysis aims to irradiate the distinguishing advantages and limitations of PETG, thereby facilitating a more informed material selection process for 3D printing applications. Tensile testing was carried out as per ASTM-D638 standard to check the ultimate tensile strength of the material, tensile load, and elongation at break. The average ultimate tensile strength was found to be 47.45 MPa. Flexural testing was done on the specimen as per ASTM-D790. The average flexural strength was found to be 66.96 MPa. The study seeks to contribute to the existing body of knowledge on material science in additive manufacturing, offering valuable insights for both academic research and practical application in the industry.

Keywords: PETG, FEA, Material Properties, Additive Manufacturing.

ICAMSF-221

Effective use of plastic to produce organic fuel for diesel engines: An experimental Study

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Plastic has entrenched itself in our daily lives, posing a significant environmental threat. While government bans on plastic and packaging materials are a step forward, they don't address the pressing issue of managing existing plastic waste. Municipal waste systems are often inadequate to handle the global plastic crisis. The abundance of plastic waste, coupled with its high energy potential, makes it a valuable resource for fuel production. One viable solution is the conversion of plastic into fuel through a thermochemical process called catalytic pyrolysis. Initially, the resulting pyro oil can be used as a fuel source for industrial furnaces or low-compression diesel engines. With further refinement through hydrogenation, it can closely resemble conventional diesel. The small-scale apparatus is designed to endure temperatures up to 600°C while remaining sealed, emitting no smoke. All equipment is contained within a carrying case. In an experiment using 1 kilogram of shredded LDPE plastic, the reactor was heated to 350°C. Vaporous fumes appeared after about 2 minutes, and droplets formed around the 5-minute mark. The resulting condensate was collected over the next hour, and the reaction stopped after 1 hour and 15 minutes. Subsequently, fuel derived from various plastic inputs underwent tests for viscosity, flashpoint, and density at the Engineering Chemistry laboratory. It was also evaluated in a 4-stroke Diesel

Engine with blends of 20%, 30%, and 50%. Real-world tests in a diesel-powered vehicle were conducted, closely monitoring and analyzing emissions.

Keywords: Pyrolysis, Catalyst, Low-density polyethylene (LDPE), Plastic solid waste (PSW),

ICAMSF-222

Advancements and Challenges in Blow Fill Seal Technology: Insights from Practical Applications in Pharmaceutical Industry

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This paper delves into the outcomes of In-Process Testing (IPT) and the manufacturing of Water for Injection (WFI) using Blow Fill Seal (BFS) technology. Emphasizing BFS's role in enhancing pharmaceutical efficiency and quality, the study explores its significance. Objectives: The paper aims to delve into the complexities of water for injection manufacturing and production technology while forecasting significant growth in BFS technology, aligning with trends in the pharmaceutical industry. Exploring global technologies fosters innovation and contributes to societal awareness and benefits. Methods: The Blow Fill Seal (BFS) technology automates container production using heated plastic and air blasts. Raw materials like high-low density polyethylene (PE) and polypropylene (PP) ensure durability. Automation via PLC and HMI systems streamlines operations, while electrical setups ensure efficiency. These methods ensure high quality, sterile containers efficiently and effectively. Findings: The investigation reveals significant growth projections for BFS technology, with the market expected to reach USD 703.22 million by 2030, driven by a compound annual growth rate (CAGR) of 6.38% between 2022 and 2031. In the Indian pharmaceutical packaging market, BFS technology accounted for approximately 3.3% of the sector's share in 2024. Training involved mastering NX CAD, machinery operations, and automation concepts, highlighting the significance of production efficiency and meticulous quality control measures during trials. Novelty: This research highlighting the importance of mastering technologies like NX CAD and navigating procurement processes. Challenges encountered during project execution underscore adaptability and problem-solving abilities, while the dynamic nature of factory work contrasts with office settings, offering valuable insights and growth opportunities.

Keywords: Water for Injection, Blow Fill Seal, NX CAD, Plastic Waste Reduction, Industrial Automation and Robotics

ICAMSF-224

Parametric Study on Wear and Corrosion Properties of MultiLayer Graphene Reinforced Titanium Alloy (Ti64) Composite

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In recent decades, titanium and titanium alloys have been of great interest owing to their attractive combination of strength-to-density ratio, hardness, and better corrosion resistance. However, there is a

continuous demand for Ti alloys with enhanced properties that will not only improve functionality but also extend the life span of the components. The present work is a step forward in developing spark plasma sintered titanium alloy (Ti64) and multilayer graphene (MLG) nanocomposites with enhanced mechanical and tribological properties for industrial applications. It gives an insight into understanding the role of adding MLG in influencing the properties of Ti64. The scan electron microscope, hardness tester, and tribometer are used to analyze the microstructure, mechanical, and tribological properties of the fabricated Ti64-MLG nanocomposites. The interface between the Ti64 and MLG showed the formation of secondary phase titanium carbide that is primarily responsible for improving the properties of nanocomposites. A detailed parametric study is performed to develop regression equations of the output responses, i.e., wear rate and corrosion (in terms of corrosion current density) as a function of input parameters, i.e., sintering temperature and wt.% of MLG. Analysis of variance predicted wt. % of MLG as the significant influential parameter with a contribution of 54.78 % and 48.72 %, followed by the sintering temperature contributing 41.25 %, and 46.22 % in determining hardness and wear rate, respectively. A minimum wear rate of 14.50 x 10^{-6} g/m, corresponding to a 54.40 % improvement compared to bare Ti64, is achieved for Ti64-0.8 wt. % MLG fabricated at 1000°C.
Keywords: Titanium alloy nanocomposites, multilayer graphene, wear, spark plasma sintering, corrosion

ICAMSF-225

Analysis of a 3D SCARA Robotic Arm for Pick-and-Place Tasks

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Analysis of a Pick and Place Selective Compliance Articulated Robot Arm (SCARA), explores innovative hybrid approaches in robotics area. It focuses on a robotic arm that combines traditional pick-and-place mechanisms with advanced 3D printing technology. Key objectives include evaluating the arm's performance, adaptability for pick-and-place tasks, and its potential in various industrial applications. This research bridges the gap between traditional and modern robotics, harnessing the benefits of 3D printing and advanced materials. This research aspires to extend the horizons of traditional robotics by capitalizing on the potential of hybrid approaches and advanced materials. By integrating 3D printing with PLA PLUS material into the SCARA robots, this study not only offers cost-effective and lightweight solutions but also unlocks a range of mechanical properties that significantly enhance its overall performance. This project underscores the significance of interdisciplinary approaches in the advancement of the field of robotics, ultimately contributing to the development of versatile and adaptable robotic systems. These systems have the potential to revolutionize pick-and-place tasks across a multitude of industries, thereby increasing efficiency, safety, and the cost-effectiveness of operation.
Keywords: SCARA, Robotic Arm, Kinematic Modelling, 3D Printing, Pick-and-Place Mechanism.

ICAMSF-227

Sustainable Biodiesel Production Using Hydrochar Catalyst from Sludge Waste with Ultrasonic-Assisted Optimization

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The increasing global energy demands and depletion of fossil fuels underscore the urgency for alternative, sustainable energy sources. Biodiesel, a renewable fuel produced through the transesterification of oils or fats with alcohol to yield fatty acid methyl esters (FAME), offers a promising solution. This study explores the use of hydrochar derived from sludge waste as a green heterogeneous catalyst in ultrasonic-assisted transesterification to produce biodiesel from Pangasius fish fat feedstock. Hydrochar's catalytic properties, combined with the integration of advanced optimization techniques, make this approach environmentally and economically viable. Using the Taguchi design of experiments, optimal reaction parameters—including reaction time, catalyst concentration, and ultrasonic power—were systematically evaluated to maximize biodiesel yield and quality. Life Cycle Assessment (LCA) was employed to assess the environmental impact of the process, ensuring alignment with green chemistry principles. Ultrasonic-assisted transesterification was utilized to significantly enhance reaction efficiency, reducing both processing time and waste generation. The results demonstrate that the optimized reaction conditions, as determined by the Taguchi method, produced biodiesel that met European EN fuel standards. Key properties such as density, kinematic viscosity, and yield were within the required specifications. Additionally, the LCA confirmed the environmental advantages of using hydrochar as a catalyst, highlighting its potential for large-scale applications. This research establishes a sustainable and cost-effective methodology for biodiesel production by leveraging waste-derived hydrochar and advanced process optimization. The combined use of ultrasonic technology and green catalysts offers a scalable solution to the global energy crisis, contributing to the broader transition towards renewable energy sources.

Keywords: Life Cycle Assessment (LCA), Fatty Acid Methyl, En-Fuel Standards,

ICAMSF-228

Tribological, Mechanical and *In Vitro* Corrosion Analysis of Magnesium Based Nanocomposites for Biodegradable Implant Applications

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Magnesium composites remain highly relevant for biodegradable implant applications due to their biocompatibility and properties such as density and elastic modulus, which closely resemble those of

human cortical bone. However, magnesium's high corrosion susceptibility in aqueous environments, such as those found in the human body, poses a significant challenge for its use in biomedical applications. Additionally, orthopedic implants require adequate load-bearing capacity. To address these issues, this study fabricated a hybrid nanocomposite using a Mg-2.5Zn as matrix, reinforced with reduced graphene oxide (rGO) and hydroxyapatite (HAp) nanoparticles, through vacuum-assisted stir casting. The composite's mechanical properties and wear resistance were evaluated through tribological analysis, while its corrosion behaviour in SBF (simulated body fluid) was assessed to determine its suitability for use as biodegradable orthopedic implants.
Keywords: Biodegradable Nanocomposites, Biodegradability, Corrosion Resistance, Vacuum Stir Casting, SBF Testing, Orthopedic Implants Materials.

ICAMSF-229

Parameter Optimization for Welding with a 6-Axis YASKAWA Arc Welding Automation on Mild Steel IS2062 using Taguchi method

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The automated welding robotic system has played a pivotal role in ensuring precision and reproducibility to achieve quality weld. This study has investigated the optimization of MIG welding parameters for mild steel IS2062 using the Taguchi method, integrated with a 6-axis YASKAWA arc welding robotic system. Critical input variables, including welding current, arc voltage, and welding speed, have been systematically analysed to enhance the tensile strength and quality of welded joints. The Taguchi L9 orthogonal array has been adopted to minimize experimental trials while maximizing output accuracy. Signal-to-noise (SNR) ratios and ANOVA have been employed to identify significant parameters influencing tensile strength. The experimental setup has involved uniform-sized polished mild steel plates and appropriate GMAW-compatible electrodes. Welding current levels of 150A, 200A, and 250A; voltages of 22V, 24V, and 26V; and travel speeds of 20 cm/min, 30 cm/min, and 40 cm/min have been tested. The experimental results have demonstrated that welding current significantly impacts tensile strength with 250A yielding the highest values. Lower voltages 22V and moderate welding speeds 30 cm/min have been found optimal for achieving consistent and high-quality welds. Findings have validated the robustness of the Taguchi method in optimizing welding parameters, with the optimal combination identified as 250A current, 22V voltage, and 30 cm/min speed. Further, it is observed that the due to the excessive current, voltage, and speed results in adverse effects such as overheating or reduced penetration. The study has highlighted the synergistic benefits of automation and the Taguchi method to provide a scalable approach to parameter optimization.
Keywords: MIG welding, Taguchi method, ANOVA, parameter optimization, tensile strength, Yaskawa robot

ICAMSF-230

Performance improvement of Diamond embedded zinc coating of copper by machine learning for heat sink application

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Diamond-incorporated Cu coatings show enhanced corrosion resistance, which is crucial for extending the service life of components in corrosive environments. The diamond particles act as a barrier, reducing the rate of corrosion. The electrodeposition method offers an economical alternative to high-temperature methods, but the optimization of parameters such as particle size and distribution remains critical for achieving the desired properties. In present work, the improvement of surface roughness, contact angle, and corrosion resistance of copper (Cu) through diamond and zinc coatings using machine learning approach. The diamond powder, time, voltage and zinc concentration has selected as process variables and analysysi of theses process parameters on corrosion rate, contact angle and surface roughness has investigated. The SEM and XRD analyse also used to find the morphological and compositional analysis.
Keywords: Machine Learning; Corrosion; Surface Roughness; Contact Angle; SEM

ICAMSF-234

Pico Hydroelectric Power Plant- Sustainable Energy Solution

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In today's world, two of the biggest issues we face are the environment and the insufficient supply of energy. As a result, many utility companies are switching to renewable energy sources to power their production. Hydropower (HP) is one of the most efficient and sustainable sources of electricity generation. HP has an outstanding efficiency rate, converting 90% of the energy from the water into electricity, in comparison with fossil fuel (FF) power plants, which only have an efficiency rate of 60% or less. Large HP plants, however, are costly and have detrimental effects on the environment. This has resulted in a focus on small-scale or pico hydropower (PHP) plants, which significantly mitigate these effects. PHP is a reliable, cost-effective, and efficient alternative power source for supplying electricity to remote or rural areas in developing countries. This informative article delves into the practical application of PHP in rural areas, including its design and development for water distribution to households. It covers several design configurations for pico hydropower systems, covering different parameters such as turbine efficiency, head height, and flow rate. The social benefits of pico hydropower plants are studied as well, including the creation of jobs, better access to electricity, and increased economic growth in rural areas. For the installation of PHP two sites, (Chamoli and Mahabaleshwar) in India have been identified and thoroughly examined and presented as case studies.
Keywords: Pico hydroelectric power plant, renewable energy, hydro turbines, sustainable

ICAMSF-235

Enhancing Solar Panel Efficiency through Anti-Dust Coated Shielding: A Review

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Solar energy has become one of the most important renewable sources, and photovoltaic (PV) systems are often used to generate electricity. Now solar energy is widely used as a clean and sustainable power source in industrial and house hold applications. Nevertheless, environmental factors particularly dust accumulation have a major impact on solar panel efficiency. When dust accumulates on solar panels, it blocks sunlight and interferes with the photovoltaic process, which lowers the panels' power output. This problem is even worse in places with dry weather or high airborne particulate matter concentrations, like deserts or industrial zones. To lessen the negative impacts of dust collection on solar panels several analyses are conducted to improve the efficiency of anti-dust coatings. Anti-dust coatings can significantly enhance the efficiency and dependability of solar energy systems by reducing the damaging effects of dust build-up on solar panels. Recent developments in nanotechnology have also produced innovative coatings with improved adhesion and durability, which are viable options for maintaining solar panel efficiency over the long term. This study provides an in-depth analysis of the efficiency of anti-dust coatings. The mechanisms, characteristics, and application methods of several anti-dust coatings such as hydrophobic, super hydrophobic, and self-cleaning coatings are covered. The review also discusses the difficulties of applying anti-dust coatings practically, including issues with cost-effectiveness, compatibility with various solar panel materials, and durability in adverse environments. The effectiveness and durability of anti-dust coatings can be maximized by carefully planning the surface, applying the coating, and maintaining it regularly.

Keywords: Anti-Soiling Coatings; Dust Mitigation; Hydrophobic Coatings; Photovoltaic (PV) Efficiency; Solar Panels.

ICAMSF-236

Numerical Exploration of Stress and Strain Dynamics in Anisotropic Materials Under Thermal and Particle Effects

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This study examines the stress and strain characteristics of anisotropic materials under simultaneous mechanical and thermal loading, offering essential insights for enhancing their performance in high-stress scenarios. The research use sophisticated computer modeling to examine the distribution of ‘tangential stress’, ‘radial stress’, and ‘tangential strain rates’ along with the material's radial span. The results indicate a non-linear tangential stress distribution, reaching a maximum of 38.2 MPa at r=0.08m, with a linear rise in radial stress from 0 MPa at inner radius (r=0.05m) to 25 MPa at the outer radius (r=0.10m). The tangential strain rate shifts from compression (-0.0125) at the inner radius to tension (+0.0056) at the outer radius, indicating important deformation zones affected by the interplay of heat and mechanical

pressures. The results underscore stress concentration zones and deformation patterns, highlighting the need of strengthening mid-radius sections to improve structural integrity. The research offers a detailed framework for the design and enhancement of anisotropic materials used in aircraft, automotive, and energy systems, especially under high operational situations. Future research will concentrate on experimental validation, examining variable factors, and conducting comparison studies using isotropic and composite materials to broaden the application of these results.

Keywords: Anisotropic materials, thermal loading, mechanical stress, tangential stress, radial stress, concentration.

ICAMSF-237

Experimental and Computational Tribological Behavior Analysis of Polymer Carbon-nanotubes Composites

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Microwave-assisted compression molding (MACM) is an innovative method for producing high-performance polymer nanocomposites. Carbon nanotubes (CNT) serve as a reinforcement to enhance the overall performance of polymers. This study focuses on the development of polymer nanocomposites of high-density polyethylene (HDPE)/CNT and polypropylene (PP)/CNT with MACM, along with their mechanical and tribological characterization. The work also entails the development of a finite element (FE) model for predicting the wear rate of nanocomposites. Experimental observations indicated that HDPE/CNT and PP/CNT composites, particularly those with elevated CNT content (10% Vf), have superior wear resistance and reduced coefficient of friction (COF) compared to unreinforced polymers. With an augmented load of 10N, 20N, and 30N, the COF stabilizes at 0.32, 0.28, and 0.23 for unreinforced HDPE, HDPE containing 5% CNT, and HDPE containing 10% CNT, respectively. Comparable tendencies are exhibited by the PP/CNT nanocomposite. Marked enhancements in hardness measures are observed in the HDPE/CNT nanocomposites, achieving 9.1% and 18.2% for 5% and 10% volume fractions of CNT, respectively. Tensile and flexural tests demonstrate significant enhancement in the elastic modulus, tensile strength, and elongation. Wear test results indicate a reduction in wear and smoother worn surfaces for the CNT-reinforced nanocomposites, consistent with SEM micrographs. Computational analysis demonstrates strong concordance with experimental data, validating the reliability of the models. The findings indicate the potential of HDPE/CNT and PP/CNT nanocomposites for applications necessitating excellent durability and reduced friction.

Keywords: Tribology, Carbon nanotubes, Polymer nanocomposites, Wear, Tensile, Hardness

ICAMSF-238

Dynamic Stress Analysis of the Lateral Condyle in Paediatric Distal Humerus Under Biomechanical Loading Conditions

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In this paper, an investigation has been done to understand the impact of load by the radius and ulna on the lateral condyle of the distal humerus in children's bones. For the study, a 3-year-old girl was observed who had a type II Gartland fracture in her left supracondylar humerus. It is well known that over some time, this type of fracture leads to a condition known as cubitus varus in which the arm abnormally bends. It was observed that the girl child developed a non-healing type fracture in the lateral humeral condyle after the injury. In order to treat this, doctors performed surgery to remove the part of the bent bone, reposition the fractured area and fix it with the help of screws. The surgery was successful which led to the healing of the arm position and healed the fracture. In the present study, an effort has been made to understand how bones respond to different loads and forces. This was achieved by analyzing the dynamic stress analysis of the bone. This study helps in understanding the behavior of the bones and analyzing the weakness in the bone which can lead to fractures or deformities which need surgery even before the injury. This study helps medical practitioners to analyze useful information regarding bone health.

Keywords: Dynamic Stress Analysis, Lateral Humeral Condyle, Paediatric Bone Structure, Biomechanical Properties, Non-Union Fracture, Load Distribution, Orthopaedic Treatment.

ICAMSF-239

The effect of the Printing Temperature on the Mechanical Strength and Dimensional Accuracy of FFF-Printed PLA and Heat-treated PLA

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Fused Filament Fabrication (FFF), a widely adopted 3D printing technology, offers a cost-effective and versatile solution for fabricating polymer-based components. Among the materials used in FFF, polylactic acid (PLA), a biodegradable polymer derived from renewable resources, stands out for its eco-friendliness and ease of processing. This study examines the effect of printing temperature on the mechanical strength and dimensional accuracy of Fused Filament Fabrication (FFF)-printed PLA and heat-treated PLA specimens. Unlike conventional studies, this research focuses on the properties of PLA that has been thermally treated prior to the printing process. PLA specimens were fabricated at varying printing temperatures ranging from 200°C to 240°C, and their tensile strength and dimensional accuracy were analyzed. The results reveal notable differences in mechanical performance and dimensional stability based on the printing temperature and the pre-treatment condition of the PLA material. Heat-treated PLA exhibited superior mechanical strength and consistent dimensional accuracy across all temperatures

compared to untreated PLA. These findings emphasize the importance of selecting appropriate material pre-treatment and printing temperatures to optimize the performance of FFF-printed PLA components.
Keywords: Fused Filament Fabrication, PLA, Heat-treated PLA, Tensile Strength

ICAMSF-240

Investigating the Mechanical and Thermal Properties of Polyester/(Sisal/e-Glass) Hybrid Reinforced Composites

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The present study aims to produce a lightweight and cost-effective composite material from natural fibers by using a hand layup technique. In this study, a hybridized sandwich composite of Polyester resin was produced using a hybrid reinforcement of Sisal and e-glass fibers. Composites were prepared with 5%, 10%, 15%, and 20% weight proportion of reinforcement fibers. Tensile strength and flexural strength tests were conducted to investigate the mechanical properties of the produced composite material whereas Dynamic Mechanical Analysis (DMA) was conducted to test the thermal properties of the fabricated composites. It was found that the samples containing 5% reinforcement fibers demonstrated the best reinforcement effects in comparison with the other reinforcement proportions. For the DMA analysis, composite samples were subjected to temperature changes to measure their viscoelastic properties, including the storage modulus (E') and damping parameter (tanδ). The dynamic mechanical properties were analyzed to determine the impact of fiber loading.
Keywords: Sisal fiber, e-Glass, composites, Dynamic Mechanical Analysis, mechanical properties, thermal properties

ICAMSF-241

Electrochemical discharge drilling of glass material using SiC mixed electrolyte for enhancing hole surface finish

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Due to the desire to produce micro-features in advanced materials that are difficult to machine such as glass, ceramics, and composites electrochemical discharge machining (ECDM) has become more and more necessary in recent years. Nevertheless, there are still challenges in improving the surface quality and accomplishing greater machining accuracy at higher depths. Recent developments in the formation of holes in glass materials highlight how
crucial it is to achieve excellent surface quality, particularly for industrial applications. Additionally, the inappropriate supply of the electrolyte underneath the tool electrode at higher depths results in the formation of non-uniform and irregular sparks. As a result, poor surface quality is obtained. The present work investigates the addition of Silicon carbide (SiC) abrasive into the electrolyte during the electrochemical discharge drilling (SiC-ECDD) of a glass material using a closed loop system of adaptive

tool feed method, implemented to prevent the tool contacts. The comparative analysis of the Surface Roughness (SR), Machining depth (MD), and Material removal rate (MRR) is carried out with and without the addition of SiC abrasive. Moreover, the effect of various concentrations of the SiC abrasive on hole characteristics is studied. It is observed that the addition of the SiC abrasive helps in the abrasion action of the finished surface and leads to a better surface finish. An overall improvement in all the responses is observed with the addition of the SiC abrasives into the electrolyte which is easily available at higher depths due to adaptive tool feed.

Keywords: ECDD, Abrasives, Spark, SiC, Surface finish, Depth, Roughness

ICAMSF-244

Enhancing the Performance of WC Turning Inserts through TiAlSiN Coating via HiPIMS Technology for Machining Inconel 718

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This research deals with the applicability of TiAlSiN coated tungsten carbide inserts for machining of the Inconel 718 alloy, which is considered to be a difficult to machine nickel based superalloy. These inserts were developed with the help of High-Power Impulse Magnetron Sputtering (HiPIMS) technologies. The prime focus was to enhance the tool life and wear resistance through advanced multilayer nano-coating, so as to exceed the limitations imposed on the use of a conventional WC insert in machining aspect. The improvement in hardness, thermal stability, and oxidation resistance of the coating was correlated to the microstructure control through the incorporation of active silicon. Furthermore, the presence of hard phases such as Ti, Al, Si and N were also confirmed by XRD and EDS mapping analysis. The experimental results revealed that the tool life of TiAlSiN coated inserts was much higher than that of normal WC inserts. Improvement in tool life of 375.4% is noticed under best condition. The optical study of wear patterns also provided additional evidence for the effectiveness of the coating, as well as the controlled flank wear and nose radius wear. This study indicates that TiAlSiN coatings applied by HiPIMS, is an effective solution for the high cutting force machining situations, such as the machining for Inconel 718, because it enhances the durability and stability of the tools.

Keywords: Cutting Tools, TiAlSiN, Tungsten Carbide, Nano Coating, HiPIMS, Machining Inconel 718

ICAMSF-245

Temperature-induced crystal polymorphism in halogen-substituted organic crystals and their impact as biomaterial in pharmaceuticals

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The halogen-substituted Schiff-based organic crystal (E)-4-Methyl-2-(N phenylcarboximidoyl)phenol was developed with a condensation reaction and given the names Polymorph-I and Polymorph-II. Although Polymorph-I crystals were grown at 283K, Polymorph-II crystals originated at 363K. A variety of methods were utilized to characterize the resultant crystals. Modifications in the crystal lattice and molecular configurations of the atoms in the crystal packing were noted in the crystal structure of polymorphs I and II, which XRD determined. Variations in the intermolecular hydrogen bond O-H-N angle, bond distance, and torsional angle discrepancies are all evidenced by molecular structure. By using FTIR and FT-Raman spectroscopy, the functional groups of the polymorphic forms were identified. The crystal's vibrational mode demonstrates that the observed band's shape and position differ from one another. UV-visible spectroscopy was used to examine the crystal's optical characteristics. It revealed that the crystal absorbs light, while the amount of absorption increased as the temperature altered. Variation in Bandgap value was observed with π–π* transitions. All these differences indicate the presence of Polymorphism in the Schiff-based crystal and their structure-property relationship. According to the application of these Polymorph-I & II, Cytotoxicity of the crystal was carried out against the Lung Cancer cell line A549. This analysis shows that the cell viability of cancer cells decreases as we increase the drug concentration in the range of 5µg/ml, 25µg/ml, 50µg/ml, 75µg/ml, and 100µg/ml. Thus, these biomaterials act as drug candidates in two crystals that exhibit variation between one another due to temperature-induced polymorphism properties.

Keywords: Polymorphism, XRD, FTIR, Anticancer, cell viability.

ICAMSF-246

Texture Bump Recess Worn Foil Journal Bearing Prediction Using Machine Learning

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This study investigates the performance, wear behavior, and predictive modeling of texture bump recess worn foil journal bearings (FJBs). Analytical models based on the compressible Reynolds equation are used to evaluate limiting stiffness coefficients for large bearing numbers and high speeds, accounting for top foil texture bump profiles and bottom foil compliance. The influence of bump extent and height on bearing stiffness is analyzed using the infinitesimal perturbation method. To optimize performance,

machine learning (ML) models, including Random Forest, Decision Trees, Support Vector Machines (SVM), and Artificial Neural Networks (ANN), predict FJB characteristics based on parameters such as bump patterns, extents, and heights. Evaluation metrics (R^2, MAE, RMSE) confirm the predictive accuracy of ML models, highlighting their potential in optimizing FJB design for improved durability and operational efficiency in high-speed applications.

Keywords: Texture, Foil journal bearing, Machine learning, Wear

ICAMSF-248

Parametric Optimization of Friction Stir Welding for Joining of AZ91D Magnesium Alloy

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Friction stir welding (FSW) is a solid-state welding process that is extensively used for the joining of metals in the aerospace and automobile sectors. This research work aims to optimize the process parameters of FSW to achieve the desired mechanical properties of AZ91D Magnesium Alloy and to analyze the microstructure of the weld zone. The experiment was designed using a Taguchi L-9 orthogonal array. AZ91D Mg Alloy plates of dimensions 50 mm × 50 mm × 5 mm were used for Friction stir welding. The Percentage contribution of each parameter was also quantified using the Statistical Process technique Anova. The tests performed were Tensile strength, % Elongation, Hardness and Microstructure analysis on the FSW weld zone. The ANOVA results indicate that transverse speed (TS) was the most significant factor, and tool tip profile (TP) was least significant for UTS, % E and Hardness.

Keywords: Friction Stir Welding, Process Parameters, Rotational Speed, Transverse Speed, Tool Tip Profile.

ICAMSF-249

Performance Enhancement in Hydrodynamic Thrust Bearings: A Comparative Study of Cooling Circuitry, Recess Geometries, and Surface Textures Using Numerical and Experimental Approaches

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Hydrodynamic thrust bearings play an indispensable role in modern high-speed machinery, where thermal management and lubrication efficiency are paramount. This research investigates the impact of advanced design modifications on the performance of thrust bearings by systematically comparing various configurations, including the integration of cooling circuitry, different deep recess geometries, and surface textures. By addressing critical issues such as excessive heat generation, uneven pressure distribution, and lubrication instability, the study aims to uncover the most effective design strategies for optimizing bearing performance. A dual-methodology approach was employed, combining numerical simulations using ANSYS CFX with experimental validations on an indigenously developed test rig. The study assessed temperature profiles, pressure distributions, and lubricant film stability across conventional

and modified bearing designs. Results demonstrate that the inclusion of cooling circuitry significantly reduced hotspot formation by enhancing heat dissipation, while tailored deep recess geometries provided uniform pressure distribution and improved film thickness stability. Surface textures, such as circular dimples, were shown to create localized hydrodynamic effects, reducing friction and enabling efficient heat transfer under dynamic operating conditions. Among the designs evaluated, the hybrid bearing featuring all three modifications—cooling circuitry, optimized recess geometries, and surface textures—delivered superior performance, achieving a 20% reduction in operating temperature and a notable increase in pressure capacity by approximately 1.2 MPa. This comparative analysis highlights the transformative potential of innovative design features in overcoming thermal challenges and improving the reliability of hydrodynamic thrust bearings for demanding industrial applications. The findings provide a robust foundation for future advancements in bearing technology.
Keywards: Thermal Management, Reliability of Hydrodynamic, Hydrodynamic Effects, Hydrodynamic Thrust

ICAMSF-250

Design and Development of a Prosthetic Hand Using Fused Deposition Modeling

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This study explores the design and development of a cost-effective, lightweight, and functional prosthetic hand using 3D printing technology. As per statistics, only 5% of amputees in India get access to prosthetics. The high cost and limited accessibility of traditional prosthetic hands pose significant challenges for individuals requiring such aid. This study identifies 3D printing as a transformative solution, which is also affordable, has customization potential, and can create complex design. The key materials focused on this project include PLA and PETG. Their strengths, durability, and aesthetics were evaluated, with PLA carbon fiber, ultimately being selected as the optimal material. This project also employed advanced tools like 3D scanning, modelling software, and additive manufacturing techniques to create prototypes that were rigorously tested for using and performance. By integrating user feedback and healthcare insights, the prosthetic hand can be met with ergonomic and functional needs. This study demonstrates how 3D printing can be used to revolutionize prosthetic design and make it accessible and affordable for a broader population. Thus, the findings also provide a foundation for future innovation, including the integration of sensors, which has motion capabilities, contributing to improved quality of life for amputees in India and worldwide. This prosthetic hand is made by keeping in mind cost reduction, weight reduction and basic functionality of holding.
Keywords: PLA, PETG, Additive Manufacturing, 3D Scanning.

ICAMSF-251

Real-Time Monitoring of NiTinol Micro Milling Using Acoustic Emission Signals for Process Optimization

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This study investigates the real-time monitoring of NiTinol micro milling using acoustic emission (AE) signals for process optimization. High-speed micro milling experiments were conducted on NiTinol sheets with varying spindle speeds, feed rates, and axial depths of cut. A L9 orthogonal array Taguchi design was employed to analyze the effects of these machining parameters on AE characteristics, including AE RMS, AE ASL, AE Counts, and AE Absolute Energy. The key findings revealed a strong positive correlation between AE RMS and both spindle speed and feed rate, indicating process instability at higher values. AE ASL exhibited a non-linear relationship with spindle speed, with optimal cutting conditions observed at mid-range speeds (35,000-40,000 RPM). AE Counts increased significantly with spindle speed, reflecting heightened wear in tool, while AE Absolute Energy showed a significant rise at higher spindle speeds, indicating increased energy dissipation. ANOVA analysis confirmed that spindle speed was the most influential factor on all AE parameters. The study underscores the importance of optimizing machining parameters to enhance stability, and machining efficiency, with implications for industries such as aerospace and biomedical engineering.

Keywords: NiTinol Micro Milling, Acoustic Emission, Process Optimization, Spindle Speed, Feed rate, AE RMS

ICAMSF-252

A Multi Photon Emission and Self-defocusing effect of Organic Non-Linear Photoluminescent Crystal: (E) -2-(((2-(2-hydroxyethoxy) ethyl) imino) methyl)-4-nitrophenol

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A new organic Non-linear Optical crystal (E)-2-(((2-(2-hydroxyethoxy) ethyl) imino) methyl)-4-nitrophenol (E-2HM4N) has been synthesized by the slow evaporation techniques. A preferred imine group of titled crystals is composed of a polar aliphatic tail and a polar aromatic head, and it self-assembles into crystals, forming a crystal, Nowadays, in fluorescence spectroscopy, imine-based biomaterials are used in many different ways. The invention specifically relates to the use of polar

covalent imines because they enable deep light penetration into biological specimens and produce high-resolution optical Photoluminescence. The self-defocussing nature of the crystal is confirmed by the multi-emission peaks in photoluminescence which is due to the strong absorption in the UV Spectroscopy. The grown crystal's luminescence property displays green emission radiation with good imaging properties. For the imaging of various biological samples, many nonlinear optical techniques have been used, including multiphoton fluorescence and harmonic generation. The title crystal has strong saturable absorption and a self-defocusing effect, as shown by third-order Non-linear Optical characteristics using a Z-scan method.

Keywords: UV; Photoluminescence; Z-scan-Self-defocusing;

ICAMSF-253

Exploring the Role of Organic Dyes and Binary Oxides in Tuning Bandgap Energy for Dye Sensitized Solar Cells

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The most promising concentrated solar technologies for the reasonably efficient and economically viable conversion of light to power are dye-sensitized solar cells (DSSCs). Three essential parts of DSSC cell are counter electrode, electrolyte with redox and dye sensitized semiconductor working electrode (CE). Recent developments have shown the advantages of using electrodes of binary metal oxide for creating enhanced dye sensitive solar cell. The current research seeks to realize effective Fe_2O_3 doped - $BaCrO_4$ based DSSCs by employing improving charge transport processes and lowering recombination rates. The visible light reactive created an absorption shift to a yellow region, where it has a 2.15 eV band gap. Property of DSSC cell is analyzed in optical, morphological, and structural aspects. The electrical device, the DSSC, was able to attain cell efficiency. DSSCs with flexible counter electrodes and photo anodes made of novel materials were created for the efficiency of DSSCs.

Keywords: Binary oxides, Cyclic voltammetry, Tunable bandgap energy

ICAMSF-254

High-velocity oblique impact behaviour of flat and curved polyurea coated aluminum alloy plates

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Polyurea coatings provide remarkable resistance to ballistic impacts by creating a robust and flexible barrier that effectively absorbs and disperses the energy generated by projectiles, thereby improving the durability and protection of surfaces subjected to significant impact forces. Consequently, it is crucial to analyze and understand their performance characteristics. This research examines the ballistic performance and energy absorption capabilities of aluminum alloy plates coated with polyurea, measuring

250mm x 250mm and 6mm in thickness, when impacted by spherical aluminum alloy projectiles with a diameter of 40mm. A three-dimensional, non-linear finite element analysis was conducted using LS-DYNA to simulate the experimental impact tests. The numerical findings were compared with experimental data for flat plates under normal impact at varying velocities, demonstrating a strong correlation. The investigation also delves into the effects of different oblique impact angles (0°, 15°, 30°, 45°, and 60°) under high-velocity conditions. Furthermore, the study assessed the impact of panel curvature and oblique angles on both longitudinal and transverse responses. The analysis of ballistic limit velocity and energy absorption for all configurations indicated that increased curvature led to an approximate 10% enhancement in energy absorption. Additionally, it was found that the ballistic limit velocity significantly increased with higher impact angles. Finally, the research presented an analysis of the damage behavior under various oblique impact scenarios.
Keywords: Polyurea, LS-Dyna, Oblique impact, Ballistic limit, High- velocity

ICAMSF-255

Assessment of Diesel Engine on Efficiency, Exergy and Emission characteristics by co-combustion of Compressed Natural Gas with Jatropha biodiesel –Ethanol Blend under Dual fuel strategies

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The uses of renewable fuels in conventional diesel engine are being considered for their potential to replace diesel with improved Efficiency and reduction in tailpipe emissions. This experimental investigation focused on assessing the impact of using compressed natural gas (CNG) as primary fuel, with jatropha-ethanol blend as pilot fuels on the efficiency, exergy and emissions metrics of diesel engine. The engine rated output varied from 1-4 kW with step size of 1 kW for three different CNG injection durations i.e. 1200, 2500, and 3700 µs respectively. The engine operated at constant speed of 1500rpm (±5). The results shown substitution of CNG at 2500 µs duration with blend of 90% Jatropha biodiesel+10% Ethanol (v/v) improve thermal efficiency (2.2-2.27%) and exergtic efficiency (1.966-2.034%) with reduction in exergy destruction rate (1.69-5.4%) and entropy generation rate (3.58- 7.28%) than baseline diesel. On the terms of emissions carbon monoxide, unburned hydrocarbon and oxides of nitrogen are found lower than baseline diesel. The outcomes of this investigation are crucial for the development of sustainable transportation solutions, which align with the global goal of reducing carbon footprints while enhancing energy efficiency.
Keywords: Jatropha-ethanol blend, CNG, Dual Fuel, Efficiency, Exergy, Emissions

ICAMSF-256

Experimental investigation of Wear and Mechanical properties of AZ91D-Al_2O_3 Composite Processed through Stir Casting Process

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In this experimental study, the AZ91D Magnesium composite reinforced with Alumina (Al_2O_3) with an average size of 3µm and varying 2wt%, 4wt% & 6wt% was fabricated by bottom pouring stir casting process. Properties like density, hardness, tensile, and compressive strength were tested for the developed composites as per the ASTM standard. As compared to AZ91D Mg alloy, the developed composites have better mechanical properties. This may be due to the presence of alumina particles in the Magnesium composite. To analyse the tribological properties of developed composite pins, the wear tests were carried out by varying the sliding distance (500, 1000, 2000m) and normal load (5, 10, 20N) using pin-on-disc apparatus at constant sliding speed of 1m/s. Higher wear resistance and coefficient of friction values were observed in AZ91D-Al_2O_3 composite as compared with AZ91D matrix alloy. The different wear mechanisms of abrasion, oxidation, and delamination on the composites pins were observed through Scanning Electron Microscope (SEM) analysis. The developed AZ91D- Al_2O_3 magnesium composites may be a suitable material for crankcases, and gearboxes components in automotive industries.

Keywords: AZ91D, Alumina, Magnesium, Composite, Stir Casting, Wear

ICAMSF-257

Synthesis and evaluation of chitosan, salicylaldoxime and 3-Fluoro-4-methylaniline act as an Estrogen Receptor Confirmed by MCF-7 Cell line

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The Bio-composite (CS-FMA) material chitosan, salicylaldoxime and, was synthesized at a temperature of 45°C. The functional groups were identified by FT-IR analysis. 3398cm^{-1} bands with (N-H) Stretching of imine in intermolecular bonding,3009cm^{-1} (C-H) in vibrational bonding of Chitosan and, 1248cm^{-1} (C-O-C) linkage of chitosan. The structure of this compound was confirmed by ^{1}H NMR and ^{13}C NMR spectroscopy analysis. The solution ^{1}H-NMR (H-2 in 8.583 and H-6 in 4.881) and ^{13}C-NMR (C-3 C=N-OH and C-6 C=N) is a confirmed structure of the Bio-composite. The purity of the bio-composite is 93% conformed to HPLC Analysis. The thermodynamical parameters Entropy = 2.431$JK^{-1}mol^{-1}$, Thermal stability = 160°C were calculated by TG/DSC. The structurally related chitosan, salicylaldoxime are targeted in various proteins in breast cancer cell lines. MCF-7 231 A cell line from human breast cancer was used to determine the cytotoxic effect of various doses of the CS-FMA scaffold.

Keyword: ^{1}H NMR and ^{13}C NMR spectroscopy, MCF-7 Cell line, Thermal stability, HPLC Analysis.

ICAMSF-259

PREPARATION AND ANTI CANCERACTIVITY OF 5NITRO SALICYLADEHYDE-HEXA METHYLENTETRAMINE CRYSTAL

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The slow evaporation solution growth approach was used to generate 5-Nitrosalicylaldehyde and Hexamethylenetetramine (5NSHMTA) single crystals by reacting the two compounds at a 1:1 stoichiometric ratio. Dash software is used to solve the structure of the formed crystal using PXRD and NMR, and the space group is determined. Using the FTIR spectrum method, the vibrational mode of five NSHMTA and their functional groups were determined. NMR spectroscopy also establishes the molecular structure. The deshielding in 1H-NMR is caused by protonation, and the accompanying signal is shown as multiplets ranging from 8.396 to 8.279 ppm. The relationship between elemental composition and morphological alterations is demonstrated by FESEM-EDX research. 5NSHMTA exhibited reduced cytotoxicity against the human liver cell line HEPG2, according to the cytotoxicity assay.
Keywords: Crystal growth, FESEM-EDX analysis, anti-cancer activity.

ICAMSF-260

Integration of Digital Twin and Additive Manufacturing towards Industry 5.0

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Industry 5.0 is considered to the upcoming segment of digital transformation of Industry 4.0 with more weightage on sustainability and human – centric applications. The technique of Additive Manufacturing (AM) is believed to contribute towards achieving the targets of Industry 5.0 with its characteristics of customization, sustainability, flexibility and smart factories. Digital Twin (DT) allows real – time simulation, monitoring and analysis of real entities and performance of the system in the physical timeline. This study will focus on the possible integration of Digital Twin and Additive Manufacturing towards achieving the implications of Industry 5.0. After conducting an extensive literature survey and identification of the various challenges in towards amalgamation of these emerging technological trends, this study tends to provide a roadmap for examination of different domains of Additive Manufacturing and its incorporation with evolving methodological trends under Digital Twin framework. It also advances the conversation by providing a thoughtful analysis of potential future research avenues.
Keywords: Digital Twin (DT), Industry 5.0, Additive Manufacturing.

ICAMSF-261

Effect of friction stir welding parameters on microstructure and mechanical properties of nanoparticle reinforced magnesium AZ91D and aluminum AA6061-T6

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The microstructure and mechanical characteristics of friction stir welding (FSW) of AA6061-T6 aluminum and AZ91D magnesium metals are investigated in this work in relation to the inclusion of SiC particles. A process insight was established to identify the optimal parameters for FSW, resulting in high-quality welds with suitable metallurgical bonding and mechanical interlocking. The groove arrangement on the faying surface of AZ91D helped to hold the nanoparticles during FSW. The addition of nanoparticles during the process helps stabilize grain boundaries by restricting their mobility and acting as barriers to grain growth. Tool tilt angle (TTA) of 2°, traverse speed (TS) of 30 mm/min, and tool rotational speed (TRS) of 700 rpm were the welding parameters that produced the maximum ultimate tensile strength (UTS) of 114.98 MPa, strain of 6.43%, and microhardness of 82.3 HV. Furthermore, joints reinforced with nanoparticles demonstrated UTS ranging from 99.67 to 114.98 MPa, surpassing non-reinforced samples. This study suggests that improper processing parameters may result in intermetallic compounds (IMCs) forming within the stir zone, which in turn can negatively impact the mechanical properties of the weldments.

Keywords: FSW, SiC nanoparticles, mechanical properties, microstructure, dissimilar metals

ICAMSF-262

Prediction of Tool Wear Depth in Friction Stir Welding Process Using Different Machine Learning Algorithms

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Friction Stir Welding (FSW) is a solid-state welding technique widely used in railway, aerospace, and automotive industries due to its numerous advantages over traditional welding processes. FSW is an effective and efficient method for welding soft materials. However, FSW of high-strength materials is challenging due to tool wear. Tool wear prediction is difficult due to the high uncertainty in the process. However, tool wear prediction is essential to operate the tool under optimal parameters. Research efforts are being made to develop better tools and strategies to mitigate tool wear and prolong tool life in FSW, particularly for hard metal alloys. Machine learning (ML) algorithms have gained widespread acceptance in manufacturing optimization and prediction. Different machine learning algorithms were applied to get an accurate tool wear prediction from parameters such as rotation speed, traverse speed, traverse distance, and distance from the shoulder. The trained ML models, linear regression, random forest regression, extreme gradient boosting (XGBoost) and extra trees regression displayed the root mean square error (RMSE) values of 0.072, 0.021, 0.023 and 0.016 and coefficient of determination (R square) values of

0.380, 0.821, 0.810 and 0.866 respectively. Among these, the Extra Trees regression model was the most effective, with R-square value of 0.866 and RMSE loss of 0.016. The developed model also applied to predict the wear depth for independently performed experiments and then compared the predicted values with actual wear depths and found a reasonably good comparison. The developed ML models offer an accurate wear depth prediction during FSW of high-strength materials.

Keywords: Machine learning, Friction stir welding, Tool Wear, Wear depth, Extreme gradient boosting, Decision trees, Extra Trees regression

ICAMSF-263

Superior tribological performance of graphene-enhanced lubrication in the piston ring -cylinder liner interface of internal combustion engine

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Friction and wear at the interface between the piston ring and the cylinder liner of an internal combustion engine remain critical challenges in improving engine efficiency and durability. To address this issue, continuous efforts have been made to enhance the tribological performance of the liner/ring pair using various anti-wear and extreme pressure additives in engine oil. With growing interest in graphene-based nano-additives, this study explores the potential of graphene nanoplatelets (GNPs) as nano-additives in polyalphaolefin (PAO) oil to improve tribological performance under extreme boundary conditions. Friction tests were conducted using cast iron piston rings, both with and without chrome coating, paired with a hypereutectic Al-25Si alloy as cylinder liner. Testing was performed under an applied normal load of 50 N and a sliding frequency of 5 Hz, using 0.5 wt% GNPs as a nano-additive in PAO oil. The results demonstrate that the addition of GNPs to PAO oil significantly reduced friction and wear by 51.8% and 94.9%, respectively. Analysis revealed that this improvement in tribological performance is attributed to the adsorption of GNPs at the contact surfaces, minimizing direct asperity interactions and enhancing load-bearing capacity by forming a protective tribofilm. Additionally, the shearing and exfoliation of GNPs contribute to a reduction in the coefficient of friction. These findings highlight the effectiveness of GNPs as oil additives, offering a promising approach to enhancing the durability and performance of highly stressed automotive components.

Keywords: Tribofilm, Graphene, Cylinder liner, Piston ring, Friction, Wear

ICAMSF-264

Enhanced Mechanical Performance of Bi-directional Carbon Fiber-Reinforced Epoxy Composites containing Nano-Graphene Filler: A Multifunctional Material Approach

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This study encompasses on the mechanical properties of bi-directional carbon fiber-reinforced epoxy composites with graphene filler addition. The incorporation of graphene, a material renowned for its exceptional strength into the epoxy matrix along with carbon bi-directional fabric to enhance the load bearing there by synergistically improve the composite's performance. The hand lay-up technique has been adopted to produce epoxy carbon fiber based nanocomposites. The various weight fractions of graphene (0, 0.2, 0.5, 0.8 and 1.2 wt.%) were dispersed uniformly into the epoxy resin matrix prepared by hand lay-up technique to evaluate their effect on the mechanical characteristics. The bi-directional carbon fiber reinforcement provides structural stability and anisotropic strength, while the graphene filler contributes to good interfacial bonding between the fiber and matrix, thereby load transfer efficiency is increased for the composites. The experimental results demonstrated significant enhancements in hardness, tensile & flexural strengths and their moduli of the composites with optimal graphene loading. Further, it highlights the potential use of graphene-filled bi-directional carbon fiber-reinforced epoxy composites for advanced applications in aerospace, automotive and marine industries requiring light weight, high-strength & modulus and impact resistance. The work discusses the incorporation of nano-graphene in the epoxy matrix with carbon fabric reinforcement for assessment of the mechanical behavior and to address the growing demand as innovative and multifunctional materials. The mechanical damage studies have been undertaken to come out with the mechanism involved using scanning electron microscopic (SEM) observations for evolving correlations between mechanical properties and microscopic features.

Keywords*:* Epoxy, Bi-directional carbon fiber, Nano-Graphene, Mechanical strengths, SEM.

ICAMSF-265

Investigation on the Compressive Characteristics of 3D Printed Functionally Graded Polymeric Lattice Structures Inspired by Nature

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Advantages offered by 3D printing to develop complex nature inspired designs has gained interest in research pertaining towards understanding and optimizing various bio-inspired designs. In the present manuscript an attempt has been made to develop functionally graded nature inspired lattice structures by 3D Printing. Further the effect of infill grading and sandwich grading on the compression behaviour of the developed lattices has been studied. Four different lattice structures made of Poly Lactic Acid (PLA) polymer viz. cubic, bamboo, auxetic and hexagonal lattice inspired by natural systems such as Cellulose, Bamboo, Reptile Skin and Honeycomb respectively have been developed by Fused Deposition Modelling (FDM) technique of 3D Printing. Compression testing was performed on a computerized Universal Testing Machine (UTM) to study the stress-strain, load-displacement behaviour and to evaluate the relative density, toughness and energy absorbed for each type of lattice. The results revealed that the various grading schemes exhibit various properties such as relative density, energy absorption, toughness, yield strength, etc. The infill grading scheme exhibited better relative density of structures and enhancing energy absorption prior to failure, with the exception of auxetic lattices. Sandwiched lattice structures exhibited better yield strength compared to uniform, infill, and edge-graded lattice configurations. Overall, hexagonal lattices exhibited the highest compressive strength, followed by bamboo, cubic, and auxetic lattices. The study suggests that grading the lattice structures by 3D Printing is an effective method to exploit the potential of natural systems in developing sustainable structures with better strength capabilities to weight ratio.

Keywords: Lattice structures; Biomechanics; Biomemetics; 3D Printing; Functionally Graded Materials; Compressive strength

ICAMSF-266

Designing and Evaluating an Ergonomic Mouse for Universal Use

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The science of ergonomics enables developers to create devices that improve comfort levels while minimizing workload and preserving overall wellness throughout continuous task performance. Computer mice used frequently at workstations produce discomfort together with musculoskeletal disorders because of extended use sessions and insufficient product design. The goals of ergonomic mice are to create comfortable hand positions and lower strain on users however these benefits remain limited since products do not manage universal size requirements nor provide sufficient support techniques for left-handed users and lack flexibility to adapt different hand grip methods. Current product designs show inadequate attention toward anthropomorphic requirements of different people groups leading to mismatched user experiences. This research analyzes hand measurements from Indian users before reviewing commercial ergonomic mice to identify design limitations for fit and grip convenience. The solution tackles user challenges that happen when moving from regular to ergonomic mice because of unusual designs or heavier weights and confusing button positions. A new proposal for an ergonomic mouse features universal dimensioning and ambidextrous handling since it offers customization options according to different grip methods together with aesthetic design qualities and weight reduction and enhanced recycling and maintainability features. The proposed design addresses essential considerations to offer comfortable and efficient operation for various categories of users including professionals, gamers and students to improve work efficiency along with wellbeing outcomes. Research shows that exclusive solutions in human-computer interaction need precise user-specific data partnership with ergonomic principles to develop innovative inclusive effective designs.

Keywords: Ergonomics, Computer mouse design, Anthropometric data, User comfort, Repetitive strain injury, Sustainable design.

ICAMSF-267

Investigation on Friction, Wear, and Antibacterial Properties of Ti6Al4V, 316L SS, CoCrMo, UHMWPE, and Alumina for Orthopaedic Applications Using Pin-on-Disc Tribometer and E. coli Bacteria

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As the number of joint replacement surgeries increases, so does the demand for biomaterials used in orthopaedic implants. This growing need has led to research on various materials, including metals, polymers, and ceramics, which offer strength, biocompatibility, and durability. The most commonly used

and validated biomaterial alloys for orthopaedic implants include Titanium (Ti6Al4V), Cobalt Chromium-Molybdenum (CoCrMo), Stainless Steel (316L SS), Ultra-High Molecular Weight Polyethylene (UHMWPE), and Alumina (Al2O3). This study aims to investigate the tribological properties, specifically friction coefficients and wear rates, using a pin-on-disc sliding wear tribometer. The goal is to identify the most suitable biomaterials that exhibit minimized friction and wear behaviour for use in bioimplants. While biocompatibility remains an area of ongoing research and debate for the biomaterials utilized in orthopaedic implants, we also conducted an antibacterial investigation of these materials using Escherichia coli under controlled environmental conditions. Zones of Inhibition (ZOI) were measured periodically over 24 hours of incubation to identify which biomaterials show the maximum extent of antibacterial activity. Our findings indicate that metallic materials generally display better tribological properties compared to polymers and ceramics. Among these, CoCrMo demonstrates a notable reduction in both the friction coefficient and wear rate compared to other metallic materials. Additionally, the ZOI values for Ti6Al4V and CoCrMo are significantly higher than those for other biomaterials, while Al2O3 shows a much lower ZOI value. The combined insights from the antibacterial and tribological properties help us identify suitable biomaterials for orthopaedic applications, particularly in joint replacement procedures.

Keywords: Biomaterials, pin-on-disc tribometer, Tribological Properties, E.coli bacteria, zone of inhibition.

ICAMSF-268

Exploring Tribo-Mechanical Potential of Boron Carbide-Reinforced Aluminum Hybrid Composites for Structural Applications Using Sparrow Search Algorithm

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This study reports a comprehensive evaluation of the impact of hybridization on the mechanical and tribological properties of boron carbide (B_4C) reinforced aluminum (LM25) metal matrix composites (MMCs). The thorough use of the stir casting method to synthesize four different MMCs by modifying the 3, 6, and 9 wt% of 50 µm B_4C particulates ensures the reliability of the results. Various mechanical characteristics (hardness and tensile strength) and tribological characteristics (specific wear rate (SWR) and coefficient of friction (COF)) were investigated using analysis of variance (ANOVA), non-linear regression modeling, and confirmation tests. It was observed that MMC_4 (91 wt% LM25 + 9 wt% B_4C) composite reveals the highest hardness and tensile strength results. A novel hybrid metaheuristic sparrow search algorithm (SSA) is applied to the current study to provide the optimum process parameters and desired SWR and COF values as 2.102 mm^3/Nm and 0.476, respectively. Scanning electron microscopy coupled with the EDS approach is used to assess the indigenously developed hybrid composites in order

to address the wear mechanism. With better properties, the fabricated hybrid composites can cater to the need for fabricating automotive exterior components as well as suspension plates, offering a potential solution to industry needs.

Keywords: AMMCs, Mechanical characteristics, Sliding wear, Microstructure, Sparrow search algorithm

ICAMSF-269

Influence of Granular Layer Thickness on CBR Values of Two Layer Subgrade Soil

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A total of 32 CBR experiments have been conducted on two-layered samples that are either unreinforced or reinforced. The two-layered subgrade is composed of a cohesive soil as the subgrade layer, which is constructed over a sediment base layer. The two layers are reinforced with three reinforcing situations (unreinforced, reinforced with nonwoven geotextile, and reinforced with geogrid) at the interface, with four compaction moisture contents values of the subgrade layers. The sand base layer was subjected to CBR experiments at three different thicknesses in both soaked and unsoaked conditions. Based on the results acquired, the thickness of the sand layer is contingent upon the strength of the subgrade clayey soil, which is in turn influenced by the soaking condition and compaction moisture. In certain samples, the threshold value of the sand layer can be determined. These samples have subgrade moisture contents levels of 8, 12, and 16% in the unsoaked condition, and eight and twelve percent in the soaked condition. In additional samples, the threshold value for the thickness of the sand basal layer is not visible.

Keywords: CBR value, Clayey soil, Geosynthetic, Two-layered subgrade.

ICAMSF-270

Influence of anisotropic flow of water on consolidation characteristics of soft clay

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The traditional technique of determining the consolidation properties of soil through the oedometer test assumes that water flows exclusively in the vertical direction. The oedometer test restricts the water's radial flow. In order to test the consolidation properties of soil, an experimental setup that takes into account various anisotropic water flows through the soil has been evaluated in this study. In certain practical situations, the radial flow of water may not be present in all directions. Anisotropic radial water flow must be considered in those situations to forecast the soil's consolidation characteristics for consequent in-situ conditions. In this study, an anisotropic flow of water was taken into account during the experimental determination of the consolidation characteristics of soil. According to experimental findings, radial flow increases the rate at which water is extracted, and anisotropic radial flow has a significant impact on the coefficient of consolidation of soil.

Keywords: Oedometer, Anisotropic, Coefficient of consolidation, Radial flow.

ICAMSF-271

Introducing Amplitude Factor for IMF Selection: A Novel Approach for Univariate and Multivariate Vibration Signal Analysis with W-kNN Classification

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Maintaining reliable gearbox condition monitoring is vital for industrial operations to prevent unexpected failures and reduce costly downtimes. Despite the availability of multiple sensors for vibration data collection in gearbox systems, research reveals a significant gap in the use of multivariate signal analysis for gear fault diagnostics. Most existing decomposition methods rely solely on univariate data, failing to leverage the rich multi-dimensional sensor outputs. This underutilization of multi-dimensional approaches limits diagnostic accuracy, highlighting the need for advanced techniques that fully exploit multi-sensor information. This research employs both univariate and multivariate signal processing techniques, such as Complementary Ensemble Empirical Mode Decomposition (CEEMD) and Multivariate Empirical Mode Decomposition (MEMD), to enhance the analysis of healthy and faulty gear conditions, ensuring a more comprehensive fault diagnosis. This study employs vibration analysis to diagnose faults in gear systems under varying loads (0 Nm, 10 Nm, 20 Nm and 30 Nm) at a constant 1000 RPM. This research introduces the Amplitude Factor (AF) as an innovative metric for selecting Intrinsic Mode Functions (IMFs), representing a transformative advancement in fault diagnosis of gear. By refining IMF selection accuracy in both univariate (CEEMD) and multivariate (MEMD) vibration signals, the AF enables more precise feature extraction, significantly enhancing diagnostic reliability. The effectiveness of the proposed Amplitude Factor (AF) based IMF selection method is benchmarked against Correlation-based and Kullback-Leibler (KL) divergence-based methods using Signal-to-Noise Ratio (SNR). The results highlight the AF-based method's superior performance in accurately identifying diagnostically significant IMFs. Following the selection of effective IMFs for each loading condition, the Fast Fourier Transform (FFT) was performed on these IMFs to detect Gear-Mesh Frequencies (GMF) and their corresponding harmonics. The results revealed that the IMFs selected through the proposed Amplitude Factor (AF) method demonstrated exceptional capability in detecting fault signatures. Furthermore, time-domain features such as peak value, standard deviation, kurtosis, and RMS were extracted from the most effective IMF to classify fault conditions using a Weighted k-nearest neighbors (W-kNN) machine learning algorithm. A comparative analysis of classification was conducted between IMFs selected via the proposed AF-based method, the correlation-based method, and the KL divergence-based method. The results reveal that our proposed method achieves the highest classification test accuracy, underscoring its superiority and validating its effectiveness.

Keywords: Empirical Mode Decomposition, Weighted k-nearest neighbors, AF-based method

ICAMSF-272

Machine Learning Driven Prediction of Silver Nanoparticles Antimicrobial Effectiveness for Biomedical Applications

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The antibacterial activities of AgNPs (silver nanoparticles) have been mostly known, but the complexities between their production parameters, type of bacterial species, and physicochemical characteristics make it challenging to estimate the Minimal Inhibitory Concentration (MIC) of silver nanoparticles. In this study, we used a hybrid Meta-Learning method, Ridge Regression, and Linear Regression three sophisticated machine learning approaches to accurately predict MIC values.

In the first phase, we reviewed published research and collected 204 data points for model training. The dataset included features such as core size, nanoparticle shape, dosage, bacterial/fungal species, and the zone of inhibition (ZOI). Then, we trained the data using three different machine-learning regression algorithms and validated the model's performance using four metrics: RMSE, MSE, MAE, and R^2. Furthermore, the importance of features used in the prediction models has been evaluated. A comparative analysis of model performance revealed that the hybrid meta-learning approach provided the most accurate predictions, achieving an R^2 score above 0.9998, surpassing traditional regression methods. We also conducted an in-depth exploratory data analysis (EDA) using high-resolution visualizations to better understand feature interactions and dataset structure. These findings demonstrate the power of machine learning in modelling nanomaterial-based antimicrobial effectiveness.

Furthermore, these improvements show great potential in biological applications such as wound healing, infection control, medicinal coatings, and targeted drug delivery. The ability to correctly estimate MIC values means that AgNP formulations can be customized to tackle specific bacterial strains, increasing efficacy while limiting potential harmful effects. Beyond medicinal applications, this predictive paradigm can be applied to broader antimicrobial treatments such as water purification, food packaging, and healthcare materials, where AgNPs play an important role in preventing microbial contamination. By merging machine learning with nanomaterial research, our study opens the door for data-driven antimicrobial material design, providing a scalable and efficient strategy for producing next-generation nanotechnology-based antimicrobial treatments.

Keywords: Silver Nanoparticles; MIC Prediction; Machine Learning; Antimicrobial Materials; Biomedical Applications

ICAMSF-273

Artificial neural network-based prediction of surface roughness and material removal rate in magnetic abrasive finishing of 17-4PH steel

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Magnetic Abrasive Finishing (MAF) has gained prominence as an effective method for achieving superior surface finish due to its adaptability, precision, and applicability for magnetic and non-magnetic materials. Residues such as burrs, recast layer, and micro-cracks generated on the surface after conventional machining/finishing can be removed with MAF. This work explores the use of Artificial Neural Network (ANN)-based, and regression-based Response Surface Modeling (RSM) for predictive modeling using experimental data from MAF of 17-4PH steel. The experiments were performed on a CNC-assis MAF setup with a novel Periodic Redistribution of Magnetic Abrasive Particles (PR-MAPs) approach. Nonlinear regression equations were obtained using Analysis of Variance (ANOVA), and predictive accuracy of ANN was evaluated against RSM and experimental results. Results indicate that process parameters highly affect surface roughness and material removal rate (MRR), which are somewhere lacking in precise modeling for process optimization and cost reduction. Among the models, ANN resulted in better predictive capability, considering complex nonlinear interactions and achieving higher accuracy. The ANN model reported an overall correlation coefficient (R) of 0.99304, with the best validation performance (MSE = 0.0031863) at epoch 1. The maximum experimental values for Percentage Change in Surface Roughness (PCSR) and MRR were 93.44% and 59.09 mg/min, while the values predicted by RSM were 92.20% and 56.97 mg/min, and those predicted by ANN were 94.44% and 59.27 mg/min, respectively. PCSR and RSM models have a maximum error of about 2%. However, for MRR, ANN showed lower errors, with maximum error of 7.59%, than 17.61% for RSM. Overall, ANN predicts the output with an error less than 10 %, demonstrating its robustness. These findings validate ANN-based modeling as a more efficient and accurate approach for optimizing MAF parameters, reducing reliance on extensive experimentation. After comparative analysis, it was confirmed that ANN consistently outperformed RSM predictions.

Keywords: Magnetic Abrasive Finishing, 17-4PH Steel, Response Surface Methodology, Artificial Neural Network, Surface Roughness, Material Removal Rate

ICAMSF-274

Influence of Cutting Parameters on Surface Roughness, Chip Morphology, and Tool Wear in Machining Additively Manufactured and Conventional IN718

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This study investigates the milling performance of additively manufactured (AM) IN718 and compared with Inconel 718 (IN718) by analysing tool wear and surface roughness under various machining conditions. Experiments were conducted for varying parameters like cutting speeds (80 m/min, 100 m/min, and 120 m/min), depths of cut (0.2 mm, 0.4 mm, and 0.6 mm), and feed rates (0.08 mm/rev, 0.1

mm/rev, and 0.12 mm/rev) respectively. The aim of this work is to compare the machinability of both alloys to identify the optimal process parameters. The tool wear is evaluated in terms of flank wear (V_b) and insert degradation followed by surface roughness studies. Based on the results and observations made, highest wear is found in AM IN718 which exhibited a tool wear of 0.886 mm. however, in machining pure IN718, highest tool wear was recorded in experiment D (CS: 120 m/min, DOC: 0.6 mm, FR: 0.08 mm/rev), showing a Vb of 0.287 mm. it shows that tool wear is increasing cutting speed and depth of cut for both the material types. In the case of surface roughness measurements, the least surface roughness (Ra) for AM IN718 was obtained in experiment E (CS: 80 m/min, DOC: 0.2 mm, FR: 0.08 mm/rev) (0.389 µm), while the highest was in experiment D (CS: 120 m/min, DOC: 0.6 mm, FR: 0.08 mm/rev) (1.001 µm). For pure IN718, experiment F (CS: 100 m/min, DOC: 0.2 mm, FR: 0.12 mm/rev) exhibited the lowest Ra (0.533 µm), whereas experiment H (CS: 100 m/min, DOC: 0.6 mm, FR: 0.1 mm/rev) had the highest (0.996 µm). The results suggest that AM IN718 tends to produce lower surface roughness under similar cutting conditions, indicating variations in material response during milling. Hence, the study provides insight into the milling behaviour of both material forms, highlighting key machining parameters that influence tool wear and surface finish. Such findings can assist the operator in optimizing milling strategies for improved performance and tool longevity in industrial applications. The chip lengths up to 0.72 mm is obtained in AM IN718 alloy, which implies that longer and continuous chips worse chip breakability compared to conventional IN718. The conventional IN718 chips are thicker and fragmented leading to better chip evacuation. Also, larger chip diameters in conventional IN718 machining which are up to 0.956 mm (Exp D), while in machining AM IN718 the maximum chip diameter measured is only 0.81 mm. It can be concluded that smaller chip diameters in AM IN718 indicate chip fragmentation which could be due to high hardness and brittleness caused by difference in microstructure. Longer chips in AM IN718 might result in tool clogging and increased cutting forces.

Keywords: Additively Manufactured (AM), Inconel 718 (IN718), Cutting Speed (CS), Feed Rate (FR), Depth of Cut (DOC), Flank Wear (V_b)

ICAMSF-275

Enhancement of Surface Texturing on Biocompatible Ti-6Al-4V Alloy Using Micro-Electric Discharge Machining

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In recent years, Micro Electrical Discharge Machining (micro-EDM) is emerged as a promising technique for surface texturing, particularly for enhancing the surface properties. Different types of micro textures can be generated by controlling the process parameters. These generated micro-sized textures have diverse applications in the biomedical, automotive, and aerospace sectors etc. Micro-EDM can be used to create the tailored surfaces with improved tribological characteristics by precisely adjusting the discharge voltage and concentration of graphite powder. In this paper, graphite powder-mixed micro-EDM (PM-µEDM) is used to create the micro-sized textures (dimple patterns) on Ti-6Al-4V work piece to improve the surface characteristics, such as wear resistance and frictional performance. This study also investigates the influence of discharge voltage and graphite powder concentration on the surface texturing of Ti-6Al-4V, for better geometrical, tribological and surface parameters. While conducting the

experiments discharge voltage is considered as 85 V and 115 V and graphite powder concentrations such as 0.4, 0.8, and 1.2 g/L are added in the dielectric medium. After experimentation the generated micro-sized textures are characterized using energy-dispersive X-ray spectroscopy (EDS), 3D surface profilometry, optical microscope and scanning electron microscopy (SEM). The energy-dispersive X-ray spectroscopy (EDS) is used to identify the different types of elements present on the surface and 3D surface profilometry is used to measure the volume of metal removal under different parameters. A carbon-rich layer is formed that considerably decreased wear and friction was validated by SEM and EDS tests. The inclusion of graphite powder promotes the creation of a carbon-rich layer on the machined surface, greatly improving hardness and tribological performance. Higher discharge voltages resulted in faster material removal and greater dimple diameters, whereas lower voltages created finer, more uniform dimple patterns with less thermal damage. Excessive amounts of graphite powder caused agglomeration, resulting in unpredictable discharges and irregular texturing, which was critical for machining stability. Overall, Micro-EDM can be a novel method to generate the micro-sized features/textures that can lead to increase in the surface properties.

Keywords: Surface texturing; Tribological performance; Dimple morphology; micro-EDM; Surface alloying; Micro channel.

ICAMSF-276

Optimization of abrasive wear behaviour of Nano SiO2/Kevlar Fiber/Epoxy Hybrid Composites

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This study investigates the mechanical and wear properties of Kevlar fiber-reinforced epoxy composites with varying concentrations of nano-silica (SiO_2) as a filler. Hybrid composites were fabricated using the hand layup method followed by compression molding, incorporating SiO_2 at 0, 1, 2, 3, and 4 wt.%. The wear behavior was analyzed through a design of experiments approach using analysis of variance (ANOVA) to establish correlations between control parameters—SiO_2 content, sliding velocity, normal load, and sliding distance—and the response variable, weight loss. The selected process parameters included normal loads of 5, 10, 15, and 20N, velocities of 1, 2, 3, and 4 m/s, and sliding distances of 200, 300, 400, and 500m. Results indicated that the composite containing 3 wt.% SiO_2 exhibited superior tensile and flexural strength compared to other compositions. Furthermore, incorporating SiO_2 effectively reduced wear, as evidenced by lower weight loss. Scanning electron microscopy (SEM) was employed to analyze the worn surfaces, revealing the wear mechanisms at play. The experimental findings closely aligned with the optimized results, confirming the reliability of the study's predictive models. These insights highlight the potential of SiO_2-reinforced Kevlar composites for applications requiring enhanced mechanical strength and wear resistance.

Keywords: Polymer nano-composites, Epoxy, Kevlar fiber, Nano SiO_2, Optimization

ICAMSF-277

Taguchi based comparison of Cutting Force, Tool Wear and Surface Roughness in Turning of Haynes 25 alloy between Cryogenically Treated and Non-Cryogenic tools

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The study investigates machining performance while turning Haynes 25 superalloy to examine cutting force, tool wear and surface roughness. A comparison is made between the performance of cryogenically treated tools with regular, non-cryogenically treated tools. In this work, Taguchi L_{27} orthogonal array design is used for experimentation for both the types of tools. The process considered cutting speed, feed rate, and depth of cut as the input parameters to analyze their effects. The response parameters considered in the present investigation are cutting force, tool wear, and surface roughness to evaluate the cutting tool performance. In addition, the tool wear mechanisms were studied with Scanning Electron Microscopy (SEM). The results shows that cryogenically treated tools perform better compared to the non-cryogenically treated tools. Tools that underwent cryogenic treatment lasted longer, required less cutting force to produce a smooth machined surface. The study also identified the optimal machining parameters (cutting speed, feed rate, and depth of cut) for both the type of tools to achieve optimal performance. However, the cryogenically treated tools consistently showed better results with a notable reduction in wear and improved surface quality compared to their untreated counterparts.

Keywords: Haynes 25, Superalloy, Taguchi L27 Method, Cryogenic Treatment, Cutting Force, Tool Wear, Surface Roughness.

ICAMSF-278

Assessing the Effect of Voltage and Tool Rotation on Micro-hole Generated Using Micro-Electric Discharge Drilling Process

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Micromachining is a precise manufacturing method used to create tiny components vital in industries like microelectronics, aerospace, and medical devices. It employs techniques like micro milling, micro-

drilling, and micro-EDM to achieve exceptional precision in producing parts, especially in MEMS, microfluidic devices, and micro-sensors, etc. Traditional machining struggles to drill tiny, accurate holes owing to tool size, material hardness, aspect ratio, and control restrictions. These holes have various applications in manufacturing industries, such as injection nozzles, drug delivery orifices, and spinneret holes. The present work involves experimental investigation and parameter optimization for micro-hole drilling using micro-electrical discharge machining (µ-EDM) to achieve precise holes with refined edges and smooth internal surfaces. Micro-EDM is a promising technique for micro-drilling in most of the applications. In present work, experiments are conducted at different voltage (95, 105, 115V) and tool rotation is considered as 500, 800 and 1100 rpm. The micro hole is drilled 200 µm brass sheet with 500 µm tungsten carbide as electrode. The feed rate and capacitance is kept constant throughout the experiment as 6 µm/sec and 1000 pF respectively. EDM oil is selected as dielectric oil and straight polarity is considered for micro-hole generation. The effect of voltage and tool rotation on is analyzed on machining performance in terms MRR, TWR, taper angle, overcut, and aspect ratio. ANOVA is used to analyse the effect of process parameter on MRR, TWR, taper angle, overcut, and aspect ratio. Results shows that voltage is the most influential parameter that effects the MRR, TWR, and aspect ratio, whereas tool rotation facilitates the rapid debris removal due to its centrifugal effect in the drilling zone. Additionally, W-GRA technique is used to optimize the process parameters. The optimal results are obtained at 115 Volts and 800 rpm. The effect of voltage and tool rotation on the surface is analyzed using FESEM.

Keywords: Micro-EDM; Micro-holes; Micro-Drilling; Brass; Overcut; Taper angle; MRR and TWR

ICAMSF-279

Corrosion behaviour of Novel Al_2O_3-La_2O_3 based HVOF composite coatings

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Corrosion failures in steel components presents a major challenge across various industries, resulting in high maintenance costs and reduced equipment lifespan, particularly in machine parts exposed to humid and saline environments. This study focuses on the development of protective coatings using Al_2O_3 as the base material and La_2O_3 as a reinforcement, with varying weight percentages (1.2%, 1.6%, and 1.8%), applied via High Velocity Oxy-Fuel (HVOF) spraying on stainless steel (SS304) substrates. The corrosion resistance of these coatings was evaluated using a potentiostat to simulate a harsh saline environment. Electrochemical behaviour was analysed through Tafel, Bode, and Nyquist plots, while Electrochemical Impedance Spectroscopy (EIS) data was further assessed using the equivalent circuit model method. The experimentation revealed that the (98.4% Al_2O_3-1.6% La_2O_3) coating exhibited the lowest corrosion rate and highest charge transfer resistance, which depicts its superior corrosion protection. Scanning Electron Microscopy (SEM), Energy Dispersive Spectroscopy (EDS), and X-ray Diffraction (XRD) analysis confirmed the presence of α-Al_2O_3 in the La_2O_3-doped coatings, which plays a crucial role in reducing porosity and improving corrosion resistance. The results obtained in this work demonstrates that the Al_2O_3-La_2O_3 composite coatings significantly enhances the corrosion resistance of steel.

Keywords: Coating, Al_2O_3, Corrosion, La_2O_3, HVOF, Rare earth oxide.

ICAMSF-280

Synthesis and Mechanical Characterization of Aluminum Alloy–SiC Nanocomposites through Ultrasonic Assisted Stir Casting Techniques

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Many industries, including aerospace, automotive, defense, and sporting goods, require lightweight materials with outstanding mechanical properties and thermal stability. Al- alloy with nano SiC particles find use in these sectors. In the current work, Al-alloy with nano SiC composites were developed using the ultrasonic aided stir casting method with varying weight percentages of SiC nano-particles. Using ultrasonification homogeneous mixing of the SiC nanoparticles in the Al alloy was achieved. For the as-cast samples and T6 heat treated samples with various weight percentages of Nano SiC, the various mechanical properties including compressive strength, micro-hardness, impact strength, and tensile strength, among others, have been examined.

ICAMSF-281

Reduction in Carbon Emissions due to Advancements in Turbine Technologies

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This paper is focused towards the advances in the field of turbine technology that will play an important part to reduce the carbon emissions globally. Considering turbines to be an integral part of power generation, aviation, and industry, the development in their technologies is resulting in decreased carbon emissions across different industries. By improving efficiency, better fuel flexibility and integration with other cutting edge advanced technologies, turbines have significantly contributed against the climate change. Also, modern turbine technologies have been successful at integrating renewable energy sources such as wind, hydro, and geothermal power. Advances in gas turbine efficiency, hybrid systems, and waste heat recovery techniques have lowered carbon footprints and enhanced economic sustainability. Developments in turbine design with extended usage of advanced materials, digital control systems, and predictive maintenance strategies, have further improved operational efficiency, reducing energy losses and environmental impacts. Furthermore, this paper also discusses case studies from various industries showcasing how innovation and integration of modern turbine technologies has lowered the greenhouse gas emissions. The advancements in turbofan engines and alternative fuel adoption in the aviation industry has resulted in significant gains in terms of fuel efficiency. Similarly, application of combined heat and power (CHP) systems have lowered the emissions while maximizing the energy utilization. The

findings in the paper highlight the critical role of the influence of the developments in turbines technology on the carbon emissions, thus industries can adopt the advancements resulting in transition towards low carbon economy and therefore supporting global sustainability goals.

Keywords: Renewable Energy Integration, Turbine technology, Carbon emissions reduction, Energy Transition, Environmental Sustainability, Energy Efficiency.

ICAMSF-282

The study of physiochemical parameters and diversity of phytoplankton at raja ka talab in kangra district himachal pradesh

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The study was carried out at the Raja ka Talab Natural Water Reservoir situated in Kangra District, Himachal Pradesh. This natural water reservoir was used for irrigation, fishing for a considerable period of time. This water reservoir was analyzed in winter season from November 2023 to February 2024. Physiochemical parameters such as air temperature, water temperature, pH, free CO_2, DO, BOD, Calcium, and Total hardness, Magnesium, and Phytoplankton diversity. The correlation coefficients of different physiochemical parameter were analyzed. The air temperature and water temperature vary 10˚C -22˚C and 6˚C- 18˚C respectively, pH was slightly acidic. DO, BOD, Calcium, Total hardness and Magnesium were in permissible limit as per the BIS. Phytoplankton includes species Oedogonium, Spirogyra, Euglena, and Anabaena was dominant in zone 1, Pediastrum, Ulothrix, phacus in zone 2. On the basis of this study, it can be concluded that the water of this pond is safe for aquatic life, fishing, irrigation and other purpose.

Keywords: Phytoplankton, Physiochemical Parameter, Natural Water Reservoir

ICAMSF-283

Investigation of Redox property and electron transfer characteristic of 5 Methyl Salicylaldeyde with aniline (5MSA) A novel organic single crystal: A potential candidate for electro chemical bio sensors

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A new Schiff base organic crystal, 5 Methyl Salcylaldehyde with aniline (5MSA), has been synthesized by slow evaporation method. The single crystal XRD study reveals that the compound crystallizes in the monoclinic crystal system. The observed cell parameters are a=4.714Å, b=19.30Å, c=12.25Å, $\alpha=90^0$, $\beta=95.71^0$, $\gamma=90^{0.}$ The chemical structure of the crystal was confirmed by recording its FT-IR spectrum, and the functional groups of the crystal were confirmed by the FT-Raman spectrum. The UV-Visible study shows that the crystal was transparent in the entire visible region, and the absorption takes place in the UV region with a lower cutoff wavelength of 392 nm. Photoluminesence studies showed an intense peak at 565 nm, and the band gap energy of 2.19 eV is higher than silicon, aluminum arsenide, and cadmium selinide. EIS measurements of 5MSA crystals were carried out to explore the kinetics of the

electrochemical process. Cyclic voltametry analysis was carried out to investigate redox properties and electron transfer characteristics. The observed values can exhibit redox activity due to presence of imine (-C=N-) and hydroxyl group electrochemical(-OH) groups makes the 5MSA crystal, a potential candidate for electrochemical sensor applications.

Keywords: SXRD; UV-Vis; FT-IR; FT-Raman; PL; EIS; CV.

ICAMSF-284

Enhancing the performance of Additive Manufactured Metal Alloy Samples: A Review on Post-Processing Techniques and Their Performance Impact

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Additive manufacturing (AM) of different materials refers to a process of making a 3D component with complex geometry and desired shapes. However, AM printed samples have some limitations like internal cracks, low corrosion and wear resistance, poor surface finish quality and higher residual stresses. These limitations

can be overcome by using advanced post processing techniques such as heat treatment, friction stir processing, different coating and polishing methods. These methods shall result in better surface finish, refined micro-structure with improved mechanical, thermal and tribological properties of the AM printed samples, making the AM sample more reliable and suitable for several industrial applications. This paper reviews the past studies of different post processing techniques such as heat treatments, polishing (conventional and un-conventional) and coating techniques and coating materials for different type of metals including stainless steel, Al-alloy, Ti-alloys High entropy alloys etc. This study also covers the micro-structural, mechanical, tribological, surface quality and corrosion behaviour of AM components. This paper also focuses on the effect of reinforcement of micro-sized metals and metal oxides particles like Al_2O_3, CNT, SiC, etc. and effect of friction stir processing on the performance of the AM component. Understanding the effect of these post-processing techniques on the performance of the final AM component. These studies will benefit industries with the consistent and balanced performance compared to conventionally manufactured metal components. The conclusions and future scopes are also discussed at the end of this paper. The future research directions should focus on the hybrid-post processing techniques, use of machine learning methods for optimizations, use of micro sized metal oxide particles during friction stir processing to enhance the performance of the metal AM components.

Keywords: Additive manufacturing, post-processing, friction stir processing, heat treatments, coatings, polishing, properties.

ICAMSF-285

Analysis of fresh and strength properties of nano-ZnO-strengthened concrete

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Incorporation of pozzolanic additives in concrete may manifest benefits in the form of heightened compressive strength and decreased permeability. Especially, nanomaterials have been found to enhance their strength and durability properties. However, this improvement is exhibited only at an optimal dosage of nanomaterials followed by a reduction in workability. The current study is focused on determining the dosage of nano-zinc oxide (NZO) required to attain the intended fresh and hardened characteristics of the concrete. The content of NZO has been varied from 0-1.2% for substituting cement in concrete. The results indicate that an increase in NZO concentration in the concrete leads to a noticeable decrease in compaction with an increase in mechanical strength. The findings have been correlated with the microstructural analysis revealing an enhanced matrix. Thus, the optimal dosage of these nanomaterials can promote sustainable construction techniques.

Keywords: Nano-Zinc Oxide, Pozzolanic Additives, Strengthened Concrete

ICAMSF-286

Mechanical properties and durability of micro-strengthened metakaolin based concrete

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Microbial-induced calcite precipitation has the potential to promote the mechanical characteristics and longevity of concrete. These benefits may manifest in the form of heightened compressive strength and decreased permeability. The incorporation of pozzolanic additives in such concrete has been further found to enhance its strength and durability properties. However, this improvement is observed at an optimal dosage of the additives. This study is focused on evaluating the optimized dosages of micro silica (MS) in metakaolin (MK) based microbial concrete to attain the optimal equilibrium between workability and the intended concrete characteristics. The content of MS has been varied from 0-15% for substituting cement in the microbial concrete. The results indicate that an increased MS concentration in the presence of MK causes a noticeable decrease in setting time with an increase in consistency and mechanical strength providing microstructural enhancement at optimal dosage. The results have been confirmed by microstructural analysis. Thus, the optimal dosage of these additives is highly desirable to enhance the structural aspects of the concrete.

Keywords: Micro Silica (MS), Micro Silica (MS), Microstructural.

ICAMSF-287

An RSM based approach to investigate the laser cladded Stellite 6 geometry

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Laser cladding is an advanced surface modification process and also considered as additive manufacturing technique for repair and rebuild of damaged surfaces. The process parameters occupy a significant role to achieve a crack-free clad with minimum dilution. In the present work, the effect of process parameters, laser power (2.5 - 3.5 kW), scan speed (15 - 25 mm/s), and powder feed rate (12 - 20 g/min) on Stellite 6 clad geometry (width, height, penetration depth and dilution) is investigated. These parameters are considered as per the central composite design and response surface methodology. A statistical model is developed followed by ANOVA analysis to determine the significant parameters with model accuracy. Further, a detailed analysis is carried and a correlation between input parameters and responses is reported. The results shows that laser power is significant to clad width and penetration depth; while clad height is affected predominantly with scan speed and followed by powder feed rate on dilution. It is found that low laser power and scan speed, and a medium powder feed rate are favorable to achieve a quality deposit with Stellite 6 alloy.
Keywords: Laser Cladding, Stellite 6, Empirical Model, Clad Geometry, Process Parameters.

ICAMSF-288

A Review of Compliant Mechanisms for Next-Generation Engineering Applications using Additive Manufacturing

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In recent times due to globalization and ever-increasing market competition, there is a growing demand for viable alternatives for enhancing and economizing operations in the industry. Rigid Body mechanisms like hinge mechanisms consist of different mechanical components required for their functioning. Due to this, they are susceptible to mechanical issues such as backlash, wear, weight and regular maintenance. Compliant Mechanisms are jointless mechanisms that use deformation of their flexible members to transfer load, motion, force or energy, thereby offering significant advantages in terms of manufacturability and performance compared to traditional rigid body mechanisms. Compliant Mechanisms work on the principle of elastic deformation, which achieve their desired motion based on their flexibility. Compliant Mechanisms can be applied across a range of industries from thrusters in the aerospace industry, to being utilized in Microelectromechanical Systems. This paper briefly explains the role of critical methodologies such as Freedom & Constraint Topology (FACT) & Pseudo Rigid Body

(PRB) modelling and how they augment design capabilities using additive manufacturing into the developments in this field and the contributions that led to the development of this technology.
This research provides valuable insights into the evolving area of Compliant Mechanisms. The ultimate objective of this paper is to understand the research done on Compliant Mechanisms and the role these mechanisms will play in the future. Furthermore, this paper also aims to introduce the concept of compliant mechanisms from its fundamental aspects, while also providing a clear will pave way for optimum operations in the future.
Keywords: Additive Manufacturing**,** Compliant Mechanisms, Freedom & Constraint Topology, Pseudo Rigid Body

ICAMSF-289

Revolutionizing Metal 3D Printing: Fabrication of Copper Components via Metal Fused Filament Fabrication

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Material Extrusion is one of the most widely adopted additive manufacturing processes. Printing with a metal-polymer composite filament, followed by debinding and sintering processes, is gaining highlights as a new avenue for metal additive manufacturing. This complete package of three stages is known as metal fused filament fabrication. In this study, a copper-polymer composite filament is used to print (shape) the green parts. Further, debinding and sintering operations were performed to obtain a metal component. Different stages of the complete process are described. The effect of shaping parameters (print temperature, bed temperature, print speed, and fan speed) on green part properties (dimensional accuracy and green part density) was studied. Based on the best parameters, successful green part printing was done, and a dense copper-rich part was achieved after debinding and sintering heating cycles. The debinding and sintering cycles were designed based on thermogravimetric analysis. An anisotropic shrinkage was observed in different directions (4.6 % in X, 10.36 % in Y, and 3.76% in Z), and geometrical deviations from the original green part were also recorded. The characterization part includes raw filament and sintered part characterization. A detailed study with parameter optimization for all three stages is further suggested for a defect-free metal component fabrication.
Keywords: Additive manufacturing, metal fused filament fabrication, metal composite filament, shaping debinding sintering, copper

ICAMSF-290

An experimental study to investigate the WEDM parameters using MCDM and meta-heuristics approaches techniques for machining of Shape Memory Alloy

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This study aims to optimize multiple machining responses in the Wire Electrical Discharge Machining (Wire-EDM) of Shape Memory Alloys (SMAs). It employs a mixed L16 Taguchi-based Response

Surface Methodology combined with Multi-Criteria Decision Making (MCDM). Wire-EDM is a non-contact process, has great potential for precise machining; however, its intricate cutting profile can compromise the strength of the machined surface, due to deformation caused by sparks in the plasma channel. This research evaluates the machinability of shape memory alloys as yield components through post-processing of premium experimental runs. The optimization process seeks to maximize the erosion rate and minimize machining time by considering five significant controllable factors: pulse on time, pulse off time, wire feed, peak current, and servo voltage, at mixed levels. The MOORA, VIKOR, and TOPSIS methods were applied to determine the optimal settings, with all methods showing consistent weightage across different alternatives. The recommended settings were validated through a confirmatory experiment, which demonstrated improvements in multi attribute responses compared to conventional Wire-EDM alternatives. Additionally, the optimal settings were further refined using a metaheuristic approach, ensuring a hybrid solution for each machining stage. Ultimately, this study provides a standardized methodology for fast and accurate prediction, leading to the optimization of erosion rate and reduction in machining time for shape memory alloys.
Keywords: WEDM; MOORA; VIKOR; MCDM: Erosion rate; Machining time

ICAMSF-292

Improving the Quality and Performance of 3D Printed Parts: A Review of Post-Processing Techniques in Additive Manufacturing

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Additive manufacturing, popularly known as 3D printing, is an improvement over traditional formative manufacturing method. With the advanced features and merits like reducing wastage of material, cost and time along with flexibility of production setting it can increase the efficiency of industrial operations. However, the technology still faces various down sides, including poor finish, geometrical fits and tolerances, anisotropy, in-printing errors, and limited mechanical strength, that cannot be easily outweighed as these suppress its practical implications. In order to improve the structural properties and performance characteristics of additively fabricated parts, post-processing treatments have gained a massive attention. The aim of this research is to provide a comprehensive, in-depth and analytical methods, parameters and results synthesis to evaluate the effectiveness of post-processing treatments applied to AM build parts. Various conditions for post-processing treatments tailored to AM processes were investigated in this review and revealed efficiency and betterment of quality of parts. Moreover, improvements in the properties like mechanical, electrical, chemical and several characteristics like durability, dimensional accuracy, surface quality and aesthetics associated with post-processing were also discussed. By identifying the current advancements and limitations, it aims to provide valuable insights into optimizing and standardizing post-processing techniques for various additive manufacturing applications.
Keywords*:* Post-processing, Heat Treatments, Surface finish, Vapor Smoothing

ICAMSF-294

Experimental investigation on the mechanical performance of PETG material fabricated using Fused Deposition Modeling technique

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Additive manufacturing technology has emerged as one of the most significant advances of the fourth industrial revolution. The fused deposition modeling (FDM) technique is one of the widely used technique of additive manufacturing technology due to its ability to fabricate intricate geometrical shapes and structures. The cost-effective fused deposition modeling (FDM) printers make it easier to manufacture parts for the biomedical, aerospace and automotive industries. The objective of this research study is to compare functionally graded samples with single infill density and infill pattern specimens and examine the effects of various process parameters on the tensile strength, flexural strength, compression strength and impact energy of polyethylene terephthalate glycol (PETG) samples printed by fused deposition modeling (FDM) technique. The experimental investigation was carried out in accordance of ASTM standards (tensile-ASTM D638, flexure ASTM D790, compression-ASTM D695 and impact-ASTM D256) at three different patterns (Gyroid, cubic and octahedral) and three different infill densities (60%,80% and 100%). The obtained results suggests that the functionally graded specimen shows highest ultimate tensile strength. The highest flexural strength was achieved with the functionally graded printed sample at 100% infill density. In compression test results it was observed that the functionally graded printed sample achieved higher compression strength. Furthermore, the highest impact energy was exhibited in specimen with single pattern (gyroid) printed at 100% infill density.

Keywords: Additive manufacturing (AM), Fused deposition modeling (FDM), Functionally graded material (FGM), Mechanical properties, Process parameters, Polyethylene terephthalate glycol (PETG)

ICAMSF-296

Strength Enhancement of PLA-TPU Layered Composite Structures through Heat Treatment

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Polylactic acid (PLA) filament is frequently utilized for 3D printing due to its remarkable mechanical qualities, such as its great strength; nevertheless, its brittleness limits its application for creating flexible structures. On the other hand, Thermoplastic Polyurethane (TPU) filament, which is also frequently used for 3D printing, is flexible and frequently utilized to produce compliant structures with modest load-bearing capacity. This study examines the mechanical behavior of additively manufactured layered composites composed of two dissimilar materials—polylactic acid (PLA) and thermoplastic polyurethane (TPU)—which are joined through interlocking phenomenon. The specimens were 3D printed in a slit-type penetration pattern to achieve mechanical interlocking between the PLA and TPU sections for an ASTM D638 standard dog-bone geometry on a dual nozzle multi-material Fused Deposition Modelling (FDM)

3D printer. The specimens were treated under various heat conditions with pressure applied at the slit interlock region with a self-made pressure application mechanism. Scanning electron microscopy (SEM) was used to analyze porosity evolution, while tensile testing quantified load-displacement behavior and elastic moduli. The findings provide insights into the thermal effects on the strength of PLA-TPU composites, offering a novel approach to improving multi-material 3D-printed structures without fusion-based bonding.

Keywords: Additively Manufactured, Porosity, Fused Material Deposition (FDM), Material Extrusion, Strength Enhancement, Scanning Electron Microscopy (SEM)

ICAMSF-297

Optimize Pine Wood Laser Cutting Parameters Using Novel BHARAT Algorithm

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Pine wood is renowned for its robust properties and finds extensive use across various industrial applications. Use of traditional machineries for cutting of pine wood results in poor quality. Hence, unconventional CO2 laser machining process for cutting of pine wood has been presented in this research. Cutting speed, power and nozzle distance are inputs whereas, surface roughness and kerf taper angle are regarded as response parameters. Response surface methodology is used to optimize laser cutting parameters. Box-Behnken design is selected for planning of experimentation. Estimation models are developed and verified for all measure responses which showed 90% accuracy. Cutting speed is the most significant factor followed by power and nozzle distance. Further, multi-objective optimization function is formulated for laser cutting condition. Genetic algorithm solves fitness function and offers optimal parameters. Later on, Pareto optimal solutions are obtained from Genetic algorithm using modified models in GA multi objective tool. Multi Attribute Decision Making techniques like BHARAT, WPM and PROMETHEE methods are further employed to obtain optimal solutions using Pareto set of alternatives. BHARAT results are consistent with results of other three techniques. This clearly demonstrates that the newly created BHARAT technique is an innovative approach that improves efficiency and speeds up decision-making.

Keywords: Laser Cutting; Pine Wood; Multi Objective Optimization; Raos Algorithms.

ICAMSF-298

Crack Propagation Characteristics in Friction Stir Processed Wire Arc Additively Manufactured ER70S-6/SS316 FGM

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This study investigates the application of Wire Arc Additive Manufacturing (WAAM) for fabricating bimetallic functionally graded material (FGM) components by depositing alternate layers of ER70S-6 and SS308L. The inherent high heat input and power density in WAAM lead to microstructural inconsistencies and defects. To counter these issues, friction stir processing (FSP) was employed using a

tool with a flat shoulder without pin. The mechanical and metallurgical properties of the processed samples were analyzed. Microstructural examination of ER70S-6 indicated the presence of ferrite with minor pearlite along the grain boundaries. The SS 316 region shows large grains with some carbide precipitation at grain boundaries. The upper layers exhibited enhanced grain refinement compared to the lower layers, primarily due to rapid cooling rates and cyclic thermal effects during deposition. This refinement, attributed to dynamic recrystallization, resulted in increased hardness post-FSP. Tensile testing revealed improved tensile strength but a reduction in elongation. The fatigue crack growth rate was found to be higher along the transverse direction compared to the longitudional direction in the bimetallic joint. It is observed that FSP can significantly enhance the mechanical performance of WAAM-fabricated bimetallic FGMs.

Keywords: WAAM, friction stir processing, bi-metallic FGM, tensile strength, fatigue

ICAMSF-299

Optimizing Customer Waiting Time in Supermarkets Using Advanced Queuing Theory and AI-Driven Analytics

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Long customer waits times at supermarket checkout counters significantly impact operational efficiency and customer satisfaction. This study presents a case analysis conducted in a food bazaar, where advanced queuing theory models (M/M/1, M/M/c) and modern optimization techniques were employed to minimize delays. The research involved real-time data collection using IoT-based queue monitoring and RFID tracking, followed by an in-depth analysis of key performance indicators, including arrival rates, service rates, and server utilization. Discrete-event simulation (ARENA, Any Logic) and Monte Carlo methods were used to model system congestion and predict service time variations. To enhance efficiency, machine learning models (Reinforcement Learning, Neural Networks) were applied to predict peak hours and dynamically allocate service counters. Big Data analytics (Hadoop, Python Pandas, SciPy) facilitated deeper insights into queue behavior, while Six Sigma methodologies (DMAIC, Lean principles) helped in reducing process variability. Further, Operations Research techniques (Linear Programming, Markov Chains, and Genetic Algorithms) optimized queue management strategies. The proposed solutions—such as AI-driven queue prediction, optimized counter allocation, and sensor-based dynamic queue management—were validated using simulation modeling and real-time experimentation. The results demonstrated a significant reduction in queue length (by 73%) and customer waiting time (by 56%), enhancing both supermarket productivity and customer experience. This study highlights the power of integrating industrial engineering tools, AI, and real-time analytics to optimize service operations in high-traffic environments.

Keywords: Queuing Theory, Discrete-Event Simulation, Machine Learning Optimization, AI-Driven Queue Management, Monte Carlo Simulation, Big Data Analytics, Genetic Algorithms, Customer Waiting Time Optimization Queuing theory, Simulation, Poisson distribution.

ICAMSF-301

AHP-Based Comparative Analysis for Route Network Efficiency

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This study proposes a structured evaluation and optimization framework for bus routes in city, integrating advanced decision-making tools to enhance public transportation efficiency. A comprehensive route assessment system is developed using multiple performance indicators in accordance with authorized regulations. The Analytic Hierarchy Process (AHP) is employed to systematically integrate qualitative and quantitative attributes, ensuring a robust evaluation of route performance. To validate the real-world applicability of this system, four bus routes are analyzed, ranked, and prioritized using a combination of Geographic Information System (GIS) for spatial analysis, Data Envelopment Analysis (DEA) for efficiency assessment, and Machine Learning (ML) techniques for predictive insights. Sensitivity analysis is performed using Expert Choice 11.5, highlighting the impact of various criteria and sub-criteria on the decision-making process. The proposed methodology serves as a powerful decision-support tool, enabling policymakers to optimize public transport networks with data-driven precision, ultimately improving urban mobility and commuter satisfaction.

Keywords: Bus Route Optimization, Analytic Hierarchy Process (AHP), Geographic Information System (GIS), Data Envelopment Analysis (DEA), Machine Learning (ML)

ICAMSF-302

Prediction and Optimization of Surface Roughness in FDM-Printed TPU Prosthetics Using ANN Modeling

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Fused Deposition Modeling (FDM) is a 3D printing (3DP) process that fabricates prosthetics using raw materials in solid form. Prosthetics produced through FDM are widely utilized in product development, particularly for functional testing. Therefore, FDM prosthetics must have a high-quality surface finish to ensure optimal performance, comfort, and aesthetics. However, prosthetics manufactured using the FDM process often exhibit relatively high surface roughness due to the inherent stair-stepping effect. Additionally, surface roughness is influenced by various process parameters. To address this issue, dip coating techniques are employed to improve the surface quality of FDM-printed Thermoplastic Polyurethane (TPU) parts. This study investigates the combined impact of key parameters, including printing process parameters such as build orientation, layer thickness, and infill density, as well as dip coating parameters such as immersion time and dip orientation, on the surface roughness of the printed TPU prosthetics. A central composite rotatable design (CCD) of experiments was used to structure the

study, and the outcomes were analyzed using profilometry and microscopic imaging. Artificial Neural Network (ANN) models were trained and tested using the measured data to predict surface roughness. Optimization of both printing and dip coating parameters was conducted. The model demonstrated a high level of accuracy in predicting average surface roughness (Ra) based on experimental values. The findings indicate that FDM-printed TPU prosthetics exhibit improved performance in terms of comfort and aesthetics.

Keyword: 3DP, Fused Deposition Modeling, Prosthetics, Surface Roughness, ANN

ICAMSF-303

Laser Cladding on Hastelloy-C276 on SS 316: An Investigation on Corrosion and wear Characteristics

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Hastelloy is a Nickel based superalloy, known for its corrosion resistance and high temperature properties. The study aims to analyze the deposition characteristics such as microstructure evolution, mechanical properties of Hastelloy-C276 cladded on SS316 substrates. In this regard 9 single tracks of Hastelloy are deposited at various process conditions following L9 Taguchi array using laser cladding. Further the as-deposited samples are investigated for microstructure variation and new phases evolution in cladding with the changing input parameters. Microstructure is observed to be columnar structure, with intermetallic comprising of Mo and Ni. Later stages, surface hardness of the cladding is measured, which shows high hardness of 320 HV at large scanning speeds, and moderate Laser power. corrosion studies have been conducted in continuation. The XRD results revealed passive protection layers of CrO and NiO on the surface, which resulted great corrosion resistance to as deposited samples.

Keywords:

ICAMSF-310

Investigation of microstructural and mechanical properties of CMT WAAM based multi-layer multi-track circular disc

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Wire Arc Additive Manufacturing (WAAM) has seen a notable rise in popularity in recent years, attributed to its high deposition rates that enable the efficient production of large-volume components. This study examines the microstructure and mechanical properties of a multi-track, multi-layered disc of low carbon steel (E70S-G) produced via the cold metal transfer (CMT) process. The strategy for deposition direction was implemented from invert to outward in step 1, followed by outward to invert in step 2, continuing through to step 5. Every step was composed of eight layers. The cross section of the sample was chosen in the transverse to radial direction for the analysis of microstructure and micro-

hardness. An analysis of the microstructure performed with Optical Microscopy (OM) and Scanning Electron Microscopy (SEM) along the build direction indicated that ferrite is the dominant phase. In contrast, pearlite is the secondary phase in a minor volume fraction. Furthermore, acicular ferrite and bainite have developed along the fusion boundaries. For the micro-hardness, the sample was divided into three distinct sections: inner zone, middle zone, and outer zone. The micro-hardness measurements along the build direction ranged from 183 HV to 238 HV, while those in the radial direction range from 192 HV to 232 HV. The change in micro-hardness within the middle zone is less pronounced than that of the inner and outer zones, as evidenced in both the build and radial directions. The results of the tensile test conducted along the tangential direction, extracted at 0° and 30°. The yield strength varied from 313.15 MPa to 350.57 MPa and ultimate strength approximately same at 0° and 30°.

Keywords: Wire arc additive manufacturing, Cold metal transfer, Scanning electron microscopy, Micro-hardness

ICAMSF-311

Multiscale Modelling of single lap adhesive joints reinforced with CNT, MWCNT, & BNT to study the Mechanical Behaviour of the bounded Joints.

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The present investigation deals with the multiscale modelling of single lap adhesive joints reinforced with different nano-tubes like Single & Multi walled Carbon Nanotubes, also with Boron Nitride Nanotubes. The joint configuration that consists of a Titanium alloy (Ti-6al-4v) and Araldite 2015 epoxy adhesive. In this Study we use different approach which combines macroscale modelling using Abaqus to simulate the single lap joint's mechanical loading and nanoscale modelling using Digi-mat to create the nanocomposite's effective material properties by using mean-field-homogenization method. Further analysing mechanical behaviour of this joints, these nanotubes are combined at various volume fractions of 1%, 2%, and 3% with epoxy adhesive. To illustrate the combined effects of the epoxy-nanotube matrix on joint performance, the macroscale model is recreated from the nanoscale material parameters. To evaluate the efficiency of each kind of nanotube reinforcement, the study focuses on inspecting important mechanical metrics, such as load-displacement characteristics, peel stress, shear stress. The goal of the study is to determine the best reinforcing design by analysing the differences in stiffness, strength, and stress across various nanotube kinds and volume fractions. Furthermore, a thorough analysis is conducted of the function of volume fraction in reducing stress concentration and improving overall structural performance. For important engineering applications like aerospace and automotive constructions, where lightweight and high-strength materials are essential, this research provides insightful information about the design and optimization of high-performance adhesive joints. The results enable the development of adhesive joint solutions for next-generation engineering applications by offering a deeper knowledge of how nanotube reinforcements affect load transfer and stress distribution.

Keywords: Multiscale modelling, Adhesive Joints, Nanotube Reinforcement, Mean-Field Homogenization Aerospace Structures, Stiffness and Strength Optimization, Cardon & Boron Nanotubes.

ICAMSF-315

Examination and Optimization of Hexa-furcated Nozzles for Enhanced Flow Dynamics in Continuous Casting Slab-Caster Molds

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In order to optimise flow characteristics and reduce slag variation in metallurgical processes, four different Hexa-furcated nozzles (HFN) configurations have been meticulously designed, fabricated, and experimentally evaluated. The methodical design choice of differentiating the side port (SP) forms, lower port angles (LPA), and upper port angles (UPA) of the nozzles was made with thorough consideration to produce distinct flow characteristics for every combination. The physical consideration to produce distinct flow characteristics for every combination. The physical prototypes of nozzles were fabricated utilising cutting-edge 3D printing technology. The parameters of the experimental water model were configured to replicate real-life flow circumstances. Water tanks were used to maintain a steady state, ensuring a continuous flow of water through the nozzles. The experimental outcomes were consistent with the simulated results. Precise measurements were conducted to analyse the pressure distributions, slag fluctuations behaviours, and flow. Nozzle 4 outperformed the other three nozzles, exhibiting a 200 UPA, a 150 LPA, and a rectangular side port. Compared to the other design, this nozzle exhibited optimal flow fluctuations.

Keywords: Continuous casting, flow, fluctuations, Hexa-furcated nozzle, Multiphase modelling.

ICAMSF-317

The Effects of Methanol-Diesel Direct Dual Fuel Injection Compression Ignition Engine

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Diesel combustion in compression ignition engines produces oxides of nitrogen, soot and greenhouse gas emissions. Substituting diesel with methanol could help reduce emissions from the engines. Typically, methanol is supplied with intake air or blended with diesel for engine use. Direct injection of methanol and diesel benefits over other fuel-air mixture preparation strategies. This work investigates the effect of methanol and diesel injection pressure on combustion and emissions characteristics. CONVERGE CFD was used for simulations, and the combustion model was validated with the experimental data. The results showed that 230 bar methanol injection pressure and 270 bar diesel injection pressure exhibited better thermal efficiency with lower exhaust emissions.

Keywords: Combustion, Diesel, Methanol, Simulations, Soot.

ICAMSF-318

An Experimental Investigation on Gunmetal to Optimize the Electric Discharge Machining Parameters Using Machine Learning

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Electric Discharge Machining (EDM) plays a pivotal role in modern precision manufacturing, particularly for machining complex and difficult-to-process materials. This research presents an extensive experimental study aimed at comparing the performance of two distinct dielectrics—standard EDM oil and EDM oil infused with Al2O3 nanoparticles—using a copper tool and gunmetal as the workpiece material. The investigation follows a robust Design of Experiments (DOE) framework based on the Taguchi L27 orthogonal array, optimizing key input parameters such as current, voltage, and pulse-on time. These parameters were carefully selected to maximize Material Removal Rate (MRR), minimize Electrode Wear Rate (EWR), and improve surface roughness characteristics (Ra, Rq, and Rz). The experiments were carried out on the Electronica Electra Plus SS35ZNC machine, and the resulting data underwent thorough Analysis of Variance (ANOVA) using a general linear model to statistically evaluate the influence of each parameter on machining performance. In addition to traditional analysis, this research leveraged machine learning algorithms to develop predictive models for forecasting machining outcomes. Six different models such as Linear Regression, Ridge Regression, Support Vector Regression (SVR), Random Forest, Gradient Boosting, and Neural Networks are used. MATLAB is used for cross-validation and hyper parameter tuning to enhance their accuracy and reliability in predicting MRR and surface roughness. Among the machine learning approaches, Gradient Boosting and Random Forest models exhibited superior predictive accuracy, particularly in minimizing errors associated with MRR and Ra. The model training process was meticulously validated, ensuring robustness in forecasting capabilities. Moreover, post-experimentation surface morphology was analyzed using optical microscopy, and the properties of the dielectrics were characterized using FTIR spectroscopy and X-ray Diffraction (XRD) analysis. These advanced techniques provided deeper insights into surface integrity and material behavior after machining. Result shows addition of nanoparticle-infused dielectrics has further enhanced the MRR, surface finish and reduces the TWR. Furthermore, this study is one of the first to integrate machine learning models for the optimization of EDM parameters, setting a new benchmark for future innovations in EDM technology. The results underscore the potential for data-driven methodologies to revolutionize precision manufacturing.

Keywords: Electric Discharge Machining; Copper; Gunmetal; ANOVA; Machine Learning, Surface Roughness

ICAMSF-319

Effect of Burnishing Lateral Feed on Surface Roughness, Microhardness and Wear Behaviour of ZE41 Magnesium Alloy

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Magnesium (Mg) alloys have become an alternative for lightweight structural applications in aerospace, automotive, electronics, and military fields. However, lower mechanical and tribological properties create a hindrance in the range of applications. Therefore, in the present work an attempt was made to enhance the wear resistance of ZE41 Mg alloy using ball burnishing process. Ball burnishing was performed with different burnishing lateral feeds ranging from 25 µm to 125 µm to investigate its effect on surface finish, microhardness, and wear resistance. The surface roughness and vickers microhardness was measured for each lateral feeds. A linear reciprocating tribometer was used for dry sliding wear test and coefficient of friction was recorded. Scanning electron microscope along with the energy dispersive X-ray spectroscopy was used to investigate the worn surface morphology. It was found that the 50 µm lateral feed exhibits the best surface finish with a reduction of 46.2 % in surface roughness compared to the unburnished alloy. The highest microhardness was observed at 50 µm lateral feed with an improvement of ~32 % compared to as-cast alloy. Higher lateral feed beyond 50 µm resulted in increased surface roughness and decreased microhardness due to surface distortion and flaking. The minimum coefficient of friction was observed as 0.15 exhibited at 50 µm lateral feed. At 50 µm lateral feed, better wear resistance with a reduction of ~40 % was achieved compared to the unburnished alloy. Improvement in surface finish and microhardness are responsible for better wear performance in the burnished alloy. Worn surfaces exhibited abrasion, oxidation, and delamination wear mechanisms in the unburnished sample. Whereas, delamination wear was absent in the burnished specimen at 50 µm lateral feed.

Keywords: ZE41 magnesium alloy, Burnishing lateral feed, Surface roughness, Microhardness, Coefficient of friction, Wear mechanism

ICAMSF-320

Experimental Investigations on mechanical performance of agro-industrial wastes as reinforcement in polymeric composites

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Due to the environmental concern and demand for high performance materials the nation is compelled to emphasesd on the development of composite materials by recycling of the waste materials. The implementations of agro-industrials waste derived biofillers with recyclable matrix will promote

sustainability and help in creating new materials. In the present work, biodegradable fillers with polytetrafluroethylene (PET) are used to develop polymeric composites structural applications such as floor tiles and partition panels as a sustainable building material. The compositions are designed with agro-waste such as coconut shell powder (CSP), crushed bamboo fiber (CBF), and rice husk ash (RHA) with PET. The composites are developed by following the compositions as 49: 10: 33: 8 (PET: CSP: CBF: RHA). In total, eleven (11) compositions were formulated through a mixture design tool. The composites are created with different percentages of matrix and fillers. The composite laminates are developed with the help of compression molding. The physical and mechanical properties such as density, water absorption, compressive strength, hardness, and flexural strength were evaluated for the developed composites. To meet the standard for floor tiles and partition panels, the developed materials are verified with ASTM standards. This research will help in identifying the most appropriate materials for particular types of structural applications.
Keywords: Agro-wastes; Bio-composites; Mechanical properties; Recycling; Reinforcement

ICAMSF-321

Investigations on the two-body Sliding wear performance of sustainable composites developed via the valorization of agro-wastes

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In the present era of rapid development, the generation of wastes is a global worriment. Due to the low-biodegradability of plastic and agricultural activities the discarded plastic wastes and agro-wastes are the major cause of concern of environment. Besides, there is an urge for the development of high performance tribo- material to meet the growing demand of diverse engineering fields. The discarded waste plastics as polytetrafluroroethylene (PET) and agro waste can be converted into useful products which helps in the production of low-cost materials for tribological applications. In this view, the research is intended to develop a hybrid composite by using PET as matrix and coconut shell powder (CSP), crushed bamboo fiber (CBF) and rice husk ash (RHA) as reinforcements. The composition is developed by using the design mixtures in different ratios of 49: 10: 33: 8 for PET: CSP: CBF: RHA. The composites are fabricated by using compression molding techniques. The investigations on the sliding wear performances were conducted by using pin on disc apparatus. The wear performances of the composites improve with the reinforcement of fillers. A good binding strength has improved at suitable fractions has improved the tribological performance of the composites. The study has demonstrated that the different agro-waste can be satisfactory used as reinforcement for the development of alternative materials.
Keywords: Friction; Sliding wear; Sustainable composites; Tribology; Recycling

ICAMSF-322

Accelerating Uncertainty Quantification in Laser Powder Bed Fusion of Inconel 718 Spur Gears through Surrogate Modelling

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Metal additive manufacturing (AM) encompasses various physical processes and parameters that influence the integrity of fabricated components. Computational simulations used to analyze the laser powder bed fusion (L-PBF) method often rely on simplifications, as comprehensively modelling every physical interaction is challenging. As AM technology advances, these simulations play an increasingly vital role in optimizing design and production workflows. A critical shortcoming, however, is the frequent absence of transparency regarding their reliability and accuracy. Addressing this oversight particularly quantifying model uncertainty is essential for validating simulations, certifying AM parts, and mitigating risks in manufacturing processes. This work presents a structured approach to investigate uncertainties in L-PBF models, identifying four root causes: approximations in model design, uncertain simulation parameters, numerical truncation errors, and calibration data discrepancies. By integrating uncertainty quantification (UQ), the framework improves the robustness of computational predictions. Thermo-mechanical models of varying complexity simulate heat dynamics and phase transformations in IN718 during L-PBF. The generalized polynomial chaos (PCE) method evaluates how input uncertainties propagate to affect yield strength distributions. The methodology is validated using published data on tensile specimens, with results compared to Monte Carlo (MC) simulations and physical test outcomes on spur gears. This enhanced approach not only demonstrates the potential of process parameter optimization in improving mechanical performance but also leads to a reduction in production costs. The findings of this research contribute valuable insights into the additive manufacturing of high-performance components, providing a pathway to increased efficiency and reduced costs in the production of metal parts.

Keywords: Additive manufacturing, Laser Powder Bed Fusion (L-PBF), Spur Gear, Process Parameters, Yield strength, Uncertainty Quantification

ICAMSF-323

Effect of Lateral Feed on the Surface Integrity, Wear and Corrosion Characteristics of the Ball Burnished 17-4 PH Stainless Steel

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This study investigated the influence of a ball burnishing lateral feed on the surface characteristics of wrought and heat-treated 17-4 PH stainless steel (SS). The 17-4 PH SS wrought samples were subjected to solution heat treatment at 1040 °C for 1 hr, followed by water quenching. Subsequently, the samples were aged at 480 °C for 1 hr and then air-cooled to room temperature. Ball burnishing was performed using 10 mm diameter WC ball with a load of 240 N, tool rotational speed of 1200 rpm, feed rate of 200 mm/min, and varying lateral feeds of 50 µm, 100 µm, and 150 µm on wrought and heat-treated 17-4 PH stainless steel (SS). Ball burnishing increased the surface microhardness and decreased the surface roughness of both wrought and heat-treated samples. The surface microhardness increased from 378 HV to 436 HV for the wrought samples, and from 442 HV to 513 HV for the heat-treated samples. For the lateral feed of 50 µm, the surface roughness decreased significantly. Specially, it reduced from 0.27 µm to 0.055 µm for wrought samples, and to 0.088 µm for heat-treated samples. The results showed that after burnishing, the specific wear rate decreased by 49.23% for a lateral feed of 50 µm of wrought 17-4 PH SS compared to that of the milled surface/as received surface. For the heat-treated samples, the specific wear rate decreased by 27.86% for a lateral feed of 50 µm for the heat treated 17-4 PH SS compared with the milled surface/as heat-treated surface. However, the heat-treated ball-burnished samples exhibited higher specific wear rates after burnishing than the wrought ball-burnished samples. Further, the corrosion resistance will be evaluated in 3.5 wt.% NaCl medium through potentiodynamic polarization techniques. Surface characterization using scanning electron microscopy (SEM) and X-ray diffraction (XRD) will be used to investigate the morphological and structural changes induced by burnishing.

Keywords: 17-4PH stainless steel, heat treatment, ball burnishing, wear resistance, corrosion resistance, scanning electron microscopy.

ICAMSF-324

A comparative study on rheological and tribological properties of Magneto-Rheological Fluids with ionic liquid as base liquid

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Magneto-Rheological (MR) fluids, essential for automotive applications like dampers and brakes, can rapidly alter viscosity under magnetic fields. This study compares MR fluids using Protic Ionic Liquids

(PIL 01 and PIL 02) as base fluids compared to traditional MR fluids with silicone oil and glycerol. Ionic liquid-based MR fluids were synthesized through acid/base neutralization reactions. Rheological and tribological tests demonstrated that these PIL-based MR fluids exhibited superior wear resistance and lower friction coefficients. These findings indicate that ionic liquid-based MR fluids have great potential as advanced smart lubricants.

Keywords: Magneto-Rheological, Magnetic Fields (MF), Rheological and Tribological.

ICAMSF-325

Optimization of Mechanical Performance of inorganic fillers reinforced recycled plastics-based composites by using Mixture Design of Experiments

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In developing nations, waste generation and its disposal are critical problems. Plastics are considered as long lasting and non-biodegradable material, which produces harmful impact on environment. The recycling of plastics by selecting them as matrix for composite parts production, perhaps indorses waste to wealth creation. In this regards, recycled-LDPE (R LDPE) and recycled HDPE (R-HDPE) considered as matrix with inorganic fillers to develop composite materials. The investigation is emphasized on the development of alternative materials for construction industry. A methodology is formulated to develop a hybrid composite through R-LDPE and R-HDPE incorporated with inorganic fillers (river sand, fly ash and lime stone powder). The filler % variation was attained with the help of mixture design of experiments approach. The mixture design of experiments approach helps to yield optimal composition % for better mechanical properties. The composites are developed by using compression molding. Study is performed to investigate the feasibility of developed materials for structural applications such as floor tiles and partition panels. In the present investigation, physical and mechanical properties of developed composite such as density, water absorption, hardness, compressive strength, tensile strength and flexural strength were studied as per the ASTM standards. The experimental results were analyzed and optimal composition % were yielded for R-LDPE and R-HDPE matrix-based composites. Furthermore, HDPE composites have exhibited better mechanical properties compared to LDPE composites. The mechanical properties of developed optimal composition composite are comparable to standard properties recommended as a floor tiles and partition panels. Hence, tile made from composite systems with R-LDPE and R-HDPE as matrix material possess the potential to replace the traditional cement-based floor tiles and panels.

Keywords: Optimizations; Mechanical properties; Polymeric composites; Recycling

ICAMSF-326

Chemical-Assisted Ultrasonic Machining of Glass: A Parametric Study for Enhanced Machining Performance

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Ultrasonic machining (USM) is an economically viable and efficient method for the precision machining of glass. However, it may lead to the production of uneven surfaces and extended processing times. This study explores chemical-assisted ultrasonic machining (CUSM) to improve material removal rate and surface integrity. CUSM integrates the mechanical action of traditional ultrasonic machining with chemical etching by incorporating 1% by volume hydrofluoric (HF) acid solution into a silicon carbide abrasive slurry. The HF acid interacts with the glass workpiece, facilitating faster material removal. This study utilizes a central composite design (CCD) in response surface methodology (RSM) to investigate the impacts of slurry concentration, ultrasonic amplitude, and abrasive grit size on material removal rate (MRR), taper angle (TA), and surface roughness (SR). The results indicate that both MRR and SR rise with elevated input parameter values, to peak values of 2.349 mm^3/min and 1.847 µm, respectively. Moreover, higher input parameter settings yield a reduced taper angle of 1.04°, which is crucial for producing accurate holes in glass components. Microstructural analysis of the machined hole is performed to elucidate the surface topography and offer insights into the material removal mechanisms. This study emphasizes the capability of CUSM to optimize glass machining operations by achieving higher MRR, superior surface quality, and accurate hole geometry.

Keywords: CUSM, Glass, RSM, Mechanical Analysis, Surface integrity

ICAMSF-327

Improved Material Removal with Thermal - assisted abrasive flow machining (Th-AFM) process

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A precise finishing technique called abrasive flow machining is mostly used to polish intricate interior and external surfaces of metallic components. Because of the low rate of material removal, this procedure is likewise slow, just like the majority of finishing operations. This method began in the aerospace industry, but it is currently used in the die-making, automotive, and biomedical implant industries, among others. Recently, there has been research into hybridizing the abrasive flow machining (AFM) process with other non-conventional machining (NCM) techniques in an effort to overcome the primary drawback of the AFM process—namely, the low material removal—and meet the demanding functional and finish requirements. The current study focuses on the creation of a thermal setup and abrasive flow machining (AFM) technique for internal hole or prismatic recess fine finishing. The novel technique is known as

thermally assisted abrasive flow machining, or Th-AFM, and it was found to cause greater material abrasion because of the combined effects of AFM and Temperature. Using the standard L_{27} orthogonal array (OA) for the experimentation plan, the various process parameters have been further optimized for the response characteristic of material removal in the current investigation, based on the Taguchi method and found to be 4.71 mg. All things considered, the Th-AFM process has a very bright future in the industries because of its ability to complete quickly, even when dealing with thin, delicate, and hard alloy components.

Keywords: Abrasive aluminiun oxide; abrasive flow machining; Types of media; Thermal AFM

ICAMSF-328

Examination of Tribological Properties of Additive Manufactured High Temperature Polymer Under Various Conditions

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Additive Manufacturing (AM) is the production of complex geometry parts layer by layer based on 3D design data. AM technologies have advantages to conventional manufacturing methods based on their ability to produce complex, lightweight and custom specific components with reduced material waste which serves sustainable manufacturing. Stereolithography (SLA) is an advanced additive manufacturing technique that utilizes a laser to selectively cure liquid photopolymer resin, creating highly detailed and precise three-dimensional structures. Initially developed for prototyping applications it is now widely used for producing end-use polymer components across various industries such as automotive, medical, and aerospace. As these SLA-manufactured parts are increasingly subjected to functional and mechanical loads, understanding their tribological properties, such as wear resistance, friction behavior, and lubrication performance, has become crucial. In this study, it is aimed to examine the tribological properties of the parts produced using high temperature resistant resin which is commercially coded as HT31 and developed for use in SLA type printers. The wear and friction behaviours of the parts, manufactured at different printing angles (0o, 30o and 90o) with SLA technology, at different lubrication (dry, machine oil and palm oil conditions - as a bio lubricant alternative) and at different loading conditions (5N and 10N), were examined by ball-on-disc standard test method. The wear amount of the samples was determined by mass loss measurements. The wear mechanisms of the samples were analysed by Scanning Electron Microscope (SEM). Findings indicate that printing orientation angle influences wear resistance and friction coefficients, with 0° angle orientation exhibiting lower friction. Additionally, palm oil stands as a potential alternative lubricant with better tribological properties compared to machine oil, reinforcing its potential as an eco-friendly, sustainable option. Under the light of this study, it can be said that lightweight structures of polymer parts to be produced in the developing SLA technology may replace metal parts in terms of its tribological properties, especially in mold, space, aviation and automotive industries.

Keywords: additive manufacturing, high temperature polymer, bio-lubricant, palm oil

ICAMSF-329

Tribological Properties of ABS Resin Reinforced with Hexagonal Boron Nitride

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Additive Manufacturing (AM) is becoming vital across aerospace, automotive, defense, and medical industries due to its design flexibility, rapid prototyping, reduced assembly needs, and ability to create complex structures. Stereolithography (SLA) is a resin-based AM method that uses UV light to cure liquid photosensitive resin, building structures layer by layer. The SLA method minimizes waste generation by using only the necessary material during production. It allows creation of lightweight and optimized designs, reducing material consumption and contributing to sustainable production. ABS resin, a durable thermoplastic composed of acrylonitrile, butadiene, and styrene monomers, offers high impact resistance, chemical durability, and machinability, making it widely used in automotive, electronics, and additive manufacturing. Its resistance to heat and mechanical stress makes it a preferred choice in engineering applications. But wear resistance of these kind of polymer parts is a great concern. In this study, tribological properties of Hexagonal Boron Nitride (HBN) reinforced ABS resin were investigated. HBN was selected as the reinforcing material because of its solid lubrication property. It is aimed to improve tribological properties of ABS resin by HBN addition and enhancing the efficiency of ABS in industrial applications. In this context, four different sample groups were designed for the study. The sample groups were prepared with 0%, 1%, 1.5%, and 2% wt HBN ratios by using a magnetic stirrer. The resulting mixtures were produced into disk-shaped samples using the SLA method. Subsequently, the weight, density, and surface roughness values of these samples were measured, and wear tests were performed in a dry environment under a 10 N load using the ball-on-disc method. Surface roughness values measured with a profilometer decreased with increasing HBN content in the samples. After the wear test, repeated weight measurements were taken to calculate weight losses. The average weight losses were found to be 0.25% for the sample with 0% HBN, 0.17% for the sample with 1% HBN, and 0.15% for the sample with 1.5% HBN. The results show that increasing HBN content reduces weight loss, enhancing wear performance through solid lubrication. This improvement boosts sustainability by increasing material efficiency, extending component lifespan, and minimizing external lubrication needs. Additionally, reduced wear lowers energy consumption in mechanical systems, making HBN-integrated ABS resin a valuable solution for durable and resource-efficient manufacturing.

Keywords: Additive Manufacturing, Hexagonal Boron Nitride (HBN), ABS resin, Tribological properties, Sustainability

ICAMSF-331

A Novel Heuristic Approach for Plant Layout Optimization Using Advanced Computational Tools

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Plant layout optimization is a crucial factor in enhancing operational efficiency and minimizing material handling costs. Traditional approaches primarily rely on rectangular departmental arrangements, which may not be the most efficient configuration. This study introduces an innovative hexagonal layout, inspired by the natural efficiency of honeycomb structures, allowing each department to be adjacent to six others, thereby improving adjacency relationships, spatial compactness, and overall workflow. This research integrates multiple plant layout optimization algorithms, including CRAFT, ALDEP, and CORELAP, in conjunction with a newly developed Honeycomb heuristic approach. The effectiveness of the proposed model is assessed using key performance metrics, including Total Closeness Rating (TCR), End Relationship Value, Centroid Distance, and Average Traveled Distance by workers, evaluated through simulation techniques. To enhance the optimization process, Hybrid Metaheuristic methods, including Genetic Algorithms (GA), were applied for layout refinement. Furthermore, the integration of advanced computational tools such as FlexSim, AnyLogic, Python, and R significantly improved the accuracy, visualization, and reliability of the experimental results. The findings indicate that the Honeycomb approach outperformed traditional methods in layout efficiency by reducing worker travel distance, improving spatial compactness, and optimizing department adjacency relationships. This study presents a novel perspective on plant layout optimization, offering a promising alternative for researchers and industry professionals seeking innovative strategies for manufacturing facility design and operational efficiency.

Keyword: Hexagonal Layout, Genetic Algorithms (GA), Total Closeness Rating (TCR).

ICAMSF-332

Multi-Criteria Decision-Making Approach Using Metaheuristic Algorithms CORELAP, ALDEP

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This paper presents a comprehensive study on the optimization of plant layout using two prominent Meta-heuristic algorithms: CORELAP and ALDEP. The plant layout optimization problem, recognized as an NP-hard challenge, in reducing cost by strategically arranging facilities and departments within a factory.

CORELAP and ALDEP have emerged as pivotal tools for addressing this complex issue. In this study, we conduct a comparative analysis of these two algorithms, applying them to a real-world case study involving a manufacturing plant. The findings reveal that both algorithms excel in optimizing the layout; however, CORELAP demonstrates superior performance in terms of computational efficiency and solution quality. Moreover, this study introduces an innovative approach that integrates Python programming with ALDEP to generate a multitude of alternative solutions. This hybrid methodology significantly enhances the ability to visualize and assess numerous layout possibilities. Through exhaustive experimentation, it becomes evident that this hybrid approach, when combined with ALDEP, yields exceptional results, surpassing the capabilities of CORELAP. In conclusion, the research underscores the vital role of optimization in modern, competitive markets. It emphasizes the significance of minimizing waste, enhancing productivity, and achieving operational excellence through the optimization of manufacturing processes, material handling, and plant layout design. The study provides valuable insights for both industry practitioners and researchers in the realm of plant layout optimization, highlighting the potential of hybrid solutions like the one presented here to drive efficiency and competitiveness in manufacturing operations.
Keywords: Plant Layout, ALDEP, CORELAP, optimization, python programming.

ICAMSF-333

BIO- INspired acoustic panels for sound quality enhancement using PLA/PETG

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Currently Bio-inspired Desing including Acoustics has transformed various fields. The research presently is trying to create innovative acoustic panels with help of 3D printing technology and bio-inspired shapes. The main motive of this study is on analyse various acoustic and mechanical properties of different shapes that is i.e, Leaf Variations, honeycomb Structures, Porus Sponge-like Design, Artificial mosses, Angled leaf. These shapes will use the PLA (Polylatic Acid) and PETG (Polyethylene Terephthalate Glycol) with 3D Printing as a primary material. These materials are used due to their satisfactory mechanical properties and acoustic characteristics. The samples thus created will undergo careful mechanical and acoustic testing including Tensile strength, compressive strength test and acoustic testing including sound absorption coefficient (SAC) measurements and frequency response analysis, Noice Reduction Coefficient (NRC), Sound Transmission Loss (STL), Reverberation Time (RT), Impedance Tube Test (ITT), ASTM C423 Test, ISO 354 Test to access their performance. The outcomes and finding this study and research will be further use to furnish the creation and development of upgraded and better acoustic panels for enhanced sound quality and efficiency.
Keywords: Bio-inspired Design, Acoustic panels, 3D Printing, Sustainable Materials, PLA (Polylatic Acid), PETG (Polyethylene Terephthalate Glycol), Acoustic Testing, Sound Quality Enhancement.

ICAMSF-336

CFD Analysis of Erosion Behavior in Bent Stainless Steel Pipes with Varying SiC Abrasive Particle Sizes

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Fluid Jet Polishing (FJP) is a technique used for finishing and machining applications. To develop a test rig capable of performing various polishing and finishing techniques, optimizing its critical components is essential. A Computational Fluid Dynamics (CFD) study was conducted to analyze the critical regions of the bent pipe. To enhance the longevity of the pipe bend, a CFD analysis using ANSYS-Fluent was performed for twelve different bend ratios and five abrasive particle sizes. A total of sixty combinations were examined to assess erosion across the pipe bend using Oka's erosion model. The study revealed that as the abrasive particle size decreases, the maximum erosion rate of the pipe bend increases for a given bend ratio. For a stainless steel (SS304) pipe with a diameter of 31.75 mm, the critical bend ratio of r/D = 2.0 exhibited the highest erosion rate. The abrasive particles with an 8000-mesh size caused the most significant erosion, with a maximum erosion rate of 1.01×10^{-6} Kg/m²·s. A bend ratio of r/D = 2.062 was selected for use in the FJP test rig, as it demonstrated 6.60 times lower maximum erosion than the critical bend ratio. This optimized bend ratio significantly extends the lifespan of the FJP test rig.

Keywords: Computational Fluid Dynamics (CFD), Erosion, Fluid jet polishing, Pipe bend

ICAMSF-340

Experimental investigation and multi objective optimization of process parameters during machining of GFRP with Abrasive Water Jet Machining (AWJM)

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Abrasive water jet machining (AWJM) is a hybrid non-conventional machining process which is widely used in machining of industrial components with complex intricate shapes as in aerospace, automobile, and marine firms. It can machine all the brittle, ductile and composites materials with high degree of precision and accuracy. Glass fiber reinforced polymer (GFRP) composites are extensively used in most of the engineering works due to their beneficial features like light weight, good corrosion resistance, strong durability, excellent fire resistance and other mechanical properties. The present research work has reported on abrasive water jet machining (AWJM) of GFRP work pieces with silicon carbide abrasives. The experiments are carried out according to the relevant design of experiment (DoE) by varying the input factors: pressure (P), traverse speed (TS), and abrasive flow rate (AFR) at three differrent levels to find the respective outputs of material removal rate (MRR) and surface roughness (Ra). Experiments are conducted with Box-Behnken Design (BBD) of response surface methodology (RSM) as design of experiment (DoE). Multi-objective optimization technique TOPSIS and GWO is applied to find the optimal setting for MRR and Ra.

Keywords: AWJM, GFRP, RSM, MRR, Ra, SEM, TOPSIS

ICAMSF-341

Implementation of Kalman Filter for Multisensor Fusion with Raspberry Pi through IoT

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In industries, ensuring accurate gas concentration monitoring is critical for safety and operational efficiency, as sensor inaccuracies and environmental noise can lead to false alarms or missed hazards. To address this problem this paper presents the implementation of a Kalman Filter for multisensor fusion using MQ series gas sensors integrated with a Raspberry Pi through an IoT framework. The system is designed to enhance the accuracy and reliability of gas concentration measurements by minimizing noise and sensor-specific inaccuracies. The MQ series sensors, known for their sensitivity to various gases, generate raw data prone to environmental interference and sensor noise. By applying a Kalman Filter, the system fuses data from multiple sensors, providing a smooth and accurate estimation of gas concentrations in real time. The Raspberry Pi serves as the computational hub, processing sensor data, applying the Kalman Filter, and enabling IoT connectivity for remote monitoring. This integration facilitates centralized data visualization, real-time alerts, and improved decision-making for industrial safety and environmental monitoring. The proposed system demonstrates a cost effective and efficient approach to improving gas detection precision, with potential applications in smart safety systems and environmental hazard management.

Keywords: *Kalman Filter, Multisensor fusion, IoT, Raspberry Pi, Industrial safety*

ICAMSF-342

Real Time Environmental Monitoring with Raspberry pi 3B+ and MATLAB for Enhanced Worker Safety through IoT

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In industrial environments, ensuring worker safety through real-time environmental monitoring is crucial. This paper proposes an integrated system that combines Raspberry Pi and MATLAB through Internet of Things (IoT) technologies to enhance worker safety with MQ2 and MQ135 sensors. The system continuously monitors air quality by detecting various pollutants and hazardous gases. The MQ135 sensor detects a wider spectrum of gases, including ammonia, carbon dioxide, and carbon monoxide, and the MQ2 sensor, which measures gases including gases like smoke. Data collected from these sensors is processed in real-time using MATLAB, which facilitates advanced data analysis, visualization, and alert generation. The system's IoT capability allows for remote monitoring and control, providing timely notifications and ensuring a proactive approach to managing workplace safety. This solution offers a cost-effective, scalable approach to maintaining safe industrial environments for employee protection with potential for adaptation in various sectors.

Keyword: Managing Workplace Safety, Cost-Effective, Internet of Things (IoT), MATLAB

ICAMSF-343

Study on Enhancing Range in Electric Vehicles through Advanced Thermal Management Strategies

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Electric vehicles (EVs) are at the forefront of sustainable mobility, but their adopΘon faces significant challenges, parΘcularly related to limited range and baΣery efficiency in varying operaΘonal environments. By extending the range of EVs, fewer charging cycles are required, minimizing emissions from power plants, especially in regions where electricity is sΘll generated using fossil fuels. This work focuses on the criΘcal role of thermal management systems in opΘmizing EV range, addressing a research gap in integraΘng advanced thermal management strategies with baΣery performance and energy conservaΘon. Unlike exisΘng studies that focus on singular thermal soluΘons, this review consolidates findings from mulΘple innovaΘve approaches, including thermal energy storage, phase change materials, fuzzy control strategies, and integrated thermal management systems. The novelty of this study lies in its comprehensive analysis of methodologies aimed at miΘgaΘng energy losses through opΘmized heat uΘlizaΘon and baΣery temperature regulaΘon. A thorough comparaΘve evaluaΘon highlights how diverse techniques, such as model predicΘve control, electro thermal recuperaΘon, and dynamic inducΘve energy transfer, contribute to range extension. Key findings from the literature reveal substanΘal improvements in range, with certain methods achieving up to 25% extension, showcasing the potenΘal for reducing carbon footprints and significant energy savings. This review also bridges theoreΘcal advancements and pracΘcal implicaΘons, offering a consolidated perspecΘve on opΘmizing EV range through thermal management. The soluΘons discussed in this paper provide valuable insights for automakers and researchers striving to overcome range-related challenges and achieve a seamless transiΘon toward electrified transportaΘon. By presenΘng an extensive analysis of thermal management strategies and their contribuΘons to range extension, this work underscores the criΘcal importance of interdisciplinary innovaΘon in advancing EV technology and concludes with potenΘal direcΘons for future research.

Keywords: Thermal Management Systems; Emissions; Thermal Energy Storage; Fossil Fuels; Carbon Footprints; Energy Efficiency; Electrified Transportaɵon.

ICAMSF-344

Predictive Maintenance and Implementation of Machine Learning in Manufacturing and Industrial 4.0 Applications.

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The Machine Learning (ML) integration in Industry 4.0 has significantly impacted the manufacturing industry. The Industrial Revolution 4.0 aims to enable smart factories that continuously collect and process production-related data by promoting the use of smart machinery, sensors, and gadgets. Through

data analysis, ML approaches develop relevant intelligence to boost industrial efficiency without drastically altering the required resources. Additionally, algorithms using machine learning offer predictive insights, enabling the recognition of complex production trends and supporting smart systems for various manufacturing activities, such as constant inspection, predictive maintenance, quality enhancement, process improvement, logistics administration, and planning tasks. Although different ML approaches have been implemented in production and manufacturing applications, many challenges remain. These challenges range from edge computing and cyber security issues in smart manufacturing to big data generation, retention, and real-time intelligent decision-making. This special issue aims to gather specialists to study ongoing experimental and theoretical research in the reinforcement of machine learning (ML) and its significance to manufacturing and production units.

Keywards: Machine Learning (ML), Industry 4.0, Smart Factories, Real-Time Intelligent

ICAMSF-345

Sustainable cutting optimization and Prediction of Surface Quality Using Artificial Neural Network under wet turning operation of 17-4 PH steel

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Sustainable manufacturing aims to boost output while utilizing fewer resources, cutting costs, and having a smaller negative impact on the environment. Regarding the expenditure of materials, power, and resources required for creation as well as the prices of manufacturing processes, the longevity of tools used in machining operations is one of the most crucial variables in this context. The necessity to remove the produced chips, the excessive heat produced during the process, or the friction among the tool and the workpiece are all potential causes. Cutting fluid is often used to lower cutting temperatures, lower friction among the tool and the work piece, add to tool life, and enhance surface quality and machining efficiency. The current research focuses on using rice bran oil as a cooling agent to produce minimum friction and reducing the cutting forces by using a TiAlN tipped tool. Taguchi's robust design was used to minimize the number of trials by means of L-9 orthogonal array. Speed (m/min), feed (mm/rev), depth of cut(mm), and rice bran oil (ml/min), were chosen as controllable process factors in the turning process, and surface roughness was engaged into consideration as performance evaluation features. The Taguchi analysis that revealed the appropriate process parameters markedly increased the turning performance when turned 17-4 PH, according to the results of the conformation tests. The rice bran oil used as a cutting fluid had significantly reduced the frictional forces and the tool insert could manage to cut all the nine samples with improved surfacewhich leads to sustainable products. The Ra was mostly dependent on feed rate and rice bran oil with the respective percentage contributions of 58.06% and 49.5% respectively.

Keywords: Sustainable Machining, Orthogonal Array, Coated Insert, Cutting Fluid, ANN and Taguchi Technique.

ICAMSF-348

Optimizing DMLS Process Parameters for Enhanced Mechanical Performance of Metallic Components

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Additive manufacturing techniques, such as Direct Metal Laser Sintering, have gained significant attention in the manufacturing industry due to their ability to fabricate complex geometries with high precision. This study investigates the mechanical properties of parts produced via DMLS, focusing on the influence of process parameters on mechanical performance. Specifically, the research explores the effects of laser power, scan speed, hatch spacing, and layer thickness on densification, microstructure evolution, and resulting mechanical strength. A range of metallic systems are considered, allowing for a comparative analysis of the impact of process parameters on different materials. The research also examines the challenges associated with achieving optimal consolidation and minimizing defects, such as porosity and cracking, in DMLS-produced parts. Understanding the relationship between process parameters and defect formation is crucial for optimizing the DMLS process and ensuring the production of high-quality parts. By systematically varying process parameters and characterizing the resulting microstructures and mechanical properties, this study aims to establish correlations that can guide the selection of optimal processing conditions. The findings will contribute to a deeper understanding of DMLS processing and provide valuable insights for optimizing parameters to achieve desired material properties in a range of metallic systems, ultimately advancing the capabilities of additive manufacturing for producing high performance components.

Keywords: DMLS; Additive Manufacturing; Microstructure; Mechanical strength; Optimisation

ICAMSF-350

Exploring the microstructure and mechanical properties of Ti 20 Zr 20 Ni 20 Co 20 Fe 20 based high entropy bulk metallic glass (HE-BMG)

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High-entropy bulk metallic glass alloys (HE-BMGs) are emerging as promising materials due to their exceptional mechanical properties and diverse applications. This study uses a vacuum arc melting process to focus on microstructure and mechanical properties to investigate the design and development of Titanium-based Ti20Zr20Fe20Co20Ni20 HE-BMG. Phase formation, microstructure and mechanical properties were investigated using X-ray diffraction, SEM-EDS, and micro-hardness testing. This study investigates the prediction of crystal structures in high-entropy alloys (HEAs) using thermophysical parameters (ΔSmix, ΔHmix, δ). The analysis suggests that Ti20Zr20Fe20Co20Ni20 likely to form a bulk

metallic glass. XRD analysis reveals amorphous structure of as-cast sample and phase formation of intermetallic compounds in Ti20Zr20Fe20Co20Ni20 after annealing. The values of Tg, Tx and ΔT are measured which indicates that the samples possess better thermal stability and also high GFA. SEM analysis confirms a dual-phase microstructure with dendritic and interdendritic regions, and EDS mapping shows elemental segregation. The developed HEA demonstrates a remarkable combination of high hardness (827.95 HV) and lightweight, rendering it a promising material for industrial and aerospace applications.

Keywords: High entropy alloy; Bulk metallic glass; Hardness; Titanium

ICAMSF-351

Fabrication of Bio-memetic low surface energy modified Cu -Al based Superhydrophobic coating Enhancing anti-corrosion efficiency of Metal by Electro-assisted Deposition

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Corrosion is an electrochemical process that degrade material's malleability, ductility, mechanical strength, and other properties, leading to significant economic losses (4-5% of a country's GDP according to NACE). Conventional coatings available in the market have limitations, including high thickness, low anti-corrosion efficiency, and poor stability. In recent years, superhydrophobic coatings have gained visibility due to their diverse applications, including corrosion resistance. In this study, a Cu-Al superhydrophobic coating was electrodeposited onto a steel substrate under varying deposition voltages and times. The coating was further modified with stearic acid, achieving a contact angle of 152°. To analyze the coating's characteristics, XRD, FTIR, SEM, roughness analysis, and open-circuit voltammetry (OCV) were conducted. The results confirmed the crystalline nature, lattice parameters, and grain sizes of copper (19.32 nm) and aluminum (22.45 nm). Corrosion resistance measurements demonstrated significant improvements, with an anti-corrosion efficiency of 98%, polarization resistance of 82,300 Ω·cm², and an exceptionally low corrosion rate of 3.4×10^{-13} mm/year. The enhanced corrosion resistance is attributed to the rough nano-flower structure, which minimizes electrolyte contact and reduces the exposed surface area.

Keywords: Hydrophocity, Corrosion Resistant, Nanotecture, Nanocomposite, Bio-Inspired.

ICAMSF-353

Predictive Modeling of 4D-Printed Elastomer Strip Deformation Using Machine Learning for Biomedical Applications

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For the industry 4.0 enabled digital biomedical and pharmaceutical sectors, additive manufacturing (AM) and four-dimensional (4D) printing have emerged as viable technologies. Layer-by-layer printing of 3D structures is what is known as AM, where as 4D printing goes one step further by enabling the printed structures to change shape or functionality over time in response to outside stimuli. To explore the reversible 4D printing behaviour of a single-layer elastomer strip during the recovery phase utilizing optimized polyurethane and Eudragit® S100 polymers with varying pH, thickness, initial weight and final weight. A material extrusion-based 3D printing technique was used to create a single-layer elastomer strip, before restoring to experiment tests, it is important to model and predict the mechanical strength in order to increase the mechanical strength of single-layer elastomer strip. Predictive modeling using machine learning approaches has proven to be the best alternative to tradinational statical tools. In this study, various machine learning algorithms, including Random Forest, k-Nearest neighbors, Adaboost, and Desion trees, and Long Short-Term Memory (LSTM) methods, were utilized to predict shape deformation during the self-triggered programming stage was accomplished using experimental methods. Error metrics consisting of Mean Square Error (MSE), Root Mean Square Error (RMSE), Correlation Coefficient (R2), Mean Absolute Percentage Error (MAPE) and Root Relative Mean Squared Error (REMSE) have been utilized to assess the performance of various models. Owing to the prediction findings, the LSTM beat all ML-based models by demonstrating the beast MSE, RMSE, and R2values.

Keywords: Additive manufacturing, 4D printing, Fused deposition modeling, AI/ML, Mechanical strength

ICAMSF-354

Some Experimental and Theoretical Study on Metal Matrix Composite Using Friction Stir Processing

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Some Experimental and Theoretical Study on Metal MatrixComposite Using Friction Stir ProcessingPooja Singh*, Audhesh Narayan, Y.G. Bala Department of Mechanical Engineering, Motilal Nehru National Institute of Technology Allahabad, Prayagraj 211004, India Metal Matrix Composite utilization is on the rise nowadays, and the technique for itsfabrication, Friction Stir Processing (FSP), is also gaining popularity. FSP serves as a methodto fabricate surface metal matrix composite for the formation of metal matrix composites suchas AlSiC (aluminium silicon carbide) and Al7075/SiC

(aluminium alloy silicon carbide). Purealuminium and aluminium alloy Al7075 are utilized as the base metals for the metal matrixcomposite, reinforcement with Silicon Carbide Powder (SiC). SiC powder is incorporated intoaluminium via blank holes, chosen over alternative processes like surface grooving due to itsminimal material wastage during friction stir processing. Mechanical attributes like surfaceroughness, hardness and tensile strength are thoroughly examined. H13 tool steel is utilized forthe FSP, featuring pin morphology that is purely cylindrical. Friction Stir Processing yieldssatisfactory outcomes for Metal Matrix Composite (MMC) production, generatingcommendable mechanical characteristics. Tensile strength of FSP specimens witnesses anincrease of 50.62% from the base metal aluminium also the hardness of Al7075/SiC increasesfrom its base metal aluminium alloy Al7075. The maximum temperature while performing FSPmeasured and compare with the theoretically obtain maximum temperature.

Keywords: Friction Stir Processing, Surface Engineering, Metal Matrix Composites, Mechanical Properties, Temperature analysis.

ICAMSF-355

Enhancing productivity of the manufacturing process through MOST, Digital Human Modelling and monitoring techniques

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Maynard Operation Sequence Technique (MOST) is a widely adopted work measurement technique used to analyze and optimize manual work processes by focusing on object movements. This study applies MOST in a medium-scale manufacturing enterprise, particularly in machining, material handling, and other manual operations, with a specific focus on press machine and wire drawing machine operations involved in bolt manufacturing. By implementing MOST and Time Study, the study quantifies Task Measurement Units (TMU), process time, and unproductive activities, leading to a detailed assessment of operational inefficiencies. Advanced techniques such as Motion Capture Analysis, Digital Human Modelling (DHM), and Artificial Intelligence (AI)-driven Ergonomic Assessment are incorporated to enhance accuracy in work measurement and operator activity evaluation. Experimentation results demonstrate a significant reduction in non-value-adding movements such as bending, stooping, and twisting, thereby improving operator posture and reducing fatigue. Additionally, Lean Manufacturing principles and IoT-enabled real-time monitoring tools are utilized to further optimize machine utilization and minimize occupational hazards. The study concludes that integrating MOST with advanced analytics and ergonomic assessments results in substantial productivity improvements, reduced operator fatigue, and an overall enhancement in workplace safety.

Keywords: MOST, Work Measurement, Ergonomics, Productivity Improvement, Digital Human Modelling, Lean Manufacturing, Motion Capture, IoT Monitoring.

ICAMSF-356

Metaheuristic Approach for Optimizing Plant Layout: A CRAFT-Based Study

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Facilities layout optimization is a crucial aspect of manufacturing industries, directly influencing production efficiency, material handling costs, and overall operational performance. This study focuses on optimizing the plant layout of an automobile parts manufacturing unit by identifying inefficiencies in the existing arrangement, such as non-productive movements and redundant material handling processes. A systematic assessment of the current facility layout is conducted, emphasizing workflow disruptions, excessive transportation distances, and non-value-adding activities. To enhance the layout efficiency, the Computerized Relative Allocation of Facilities Technique (CRAFT) is employed as a meta-heuristic approach to optimize the spatial arrangement of departments. CRAFT iteratively improves the layout by swapping adjacent departments to minimize transportation costs and reduce material handling inefficiencies. In addition to CRAFT, advanced optimization techniques such as Genetic Algorithms (GA) and Simulated Annealing (SA) are explored to enhance solution quality and escape local optima. Multi-objective optimization frameworks are considered to balance trade-offs between space utilization, interdepartmental movement, and workflow continuity. The proposed methodology integrates heuristic and meta-heuristic approaches to achieve a layout that reduces total transportation distance, enhances productivity, and improves overall operational efficiency. The results demonstrate a significant improvement in the facility's performance, validating the effectiveness of hybrid optimization techniques in plant layout optimization. This study provides a comprehensive framework for industries seeking to optimize their production layouts while maintaining flexibility and adaptability to future changes.

Keyword: Allocation of Facilities Technique, Simulated Annealing (SA)

ICAMSF-357

Mechanical behavior and machining characteristics of Al7075-SiC-Graphene hybrid metal matrix composites

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In the present work, hybrid composites of AA7075-SiC-graphite flakes were produced with an aim to study the role of incorporated reinforcements on the mechanical performance and machining behavior during turning. The fraction of SiC was selected as 5% with varying graphite flakes percentage (1, 2 and 4%) and the composites were produced by stir casting route. With the increased content of graphene, the average grain size was measured as decreased in the composite form 96.5 ± 6.6 µm to 66.2 ± 4.1 µm. Increased hardness was observed for the composites compared with the base alloy and the composites with 5% SiC reinforcement. From the tensile properties, increased ultimate tensile strength and yield strength was observed for the composites compared with the base alloy. However, the ductility was retained in the composites up to 2% of graphite flakes and with the increased content up to 4%, the ductility was observed as decreased. Machining experiments were carried out at two different speeds (325 and 715 RPM) and feeds (0.04 and 0.08 mm/revolution) considering the depth of cut constant (0.1 mm). In all the composites, lower cutting forces were observed at higher cutting speed and lower feed rate. However, with the increased graphene, lower cutting forces were observed for the composite. It can be understood that the presence of graphene in Al-SiC composites has a significant effect on increasing the mechanical performance and improving the machineability.

Keywords: Hybrid MMCs, Al7075, graphene, machinability, mechanical performance.

ICAMSF-358

Incorporating fish bone derived nano-hydroxyapatite into pure zinc to produce bio-degradable composites for implant applications

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In the present work, nano-HA was produced from fish bones and characterized by X-ray diffraction and transmission electron microscope. The produced nano-HA particles have ~ 50 nm in size with acicular morphology. Composites of Zn-HA were produced with different fractions of HA (0, 2.5, 5 and 10 % by weight). The role of added HA into Zn on mechanical properties of the produced composites were evaluated. With the increased HA content, hardness was increased up to 70 % in Zn-10%HA. However,

due to the increased brittleness, fracture toughness of the composites was decreased at higher fractions of HA (5 and 10%) compared with 0% and 2.5% HA. Tensile properties assessed by conducting uni-axial tensile tests indicated the promising role of adding nano-HA into Zn on increasing the tensile properties significantly. However, with the increased fraction of HA, the ductility of the composite was measured as decreased as reflected in the lower % of elongation. The studies demonstrate that incorporating nano-HA derived from fish bones can enhance the mechanical properties of Zn composite for degradable implant applications. However, the HA content is suggested to limit to lower amounts to yield higher benefit.
Keywords: Zinc composites, degradable implants, hydroxyapatite, mechanical properties,

ICAMSF-359

Microstructural studies and mechanical performance of AZ91 Mg alloy subjected to solutionizing heat treatment

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In the current work, AZ91 magnesium (Mg) alloy was subjected to solutionizing treatment for different soaking times (4, 8, 16 and 24 h). With the increased soaking time, the microstructure of AZ91 Mg alloy was significantly altered. The intermetallic phase ($Mg_{17}Al_{12}$) was significantly decreased at the grain boundaries. The eutectic regions next to the intermetallic regions were disappeared. These findings from the microstructures suggest the development of supersaturated grains with rich in Al dissolution. XRD analysis confirms the decreased intermetallic phase as observed with the decreased intensities of the corresponding peaks. Hardness measurements indicated higher hardness for the solutionized AZ91 alloys with uniform distribution. From the tensile tests, higher strength and retained ductility was observed for the solutionized alloys. Among all the solutionized alloys, samples heat treated at 8 h and 16 h soaking time exhibited similar performance. With the increased soaking time to 24 h, no significant improvement was observed which suggest that the effect of solutionizing is optimum up to 8 h of soaking time.
Keywords: AZ91 Mg alloy, solutionizing, mechanical performance, intermetallic, solid solution

ICAMSF-360

Characterization, wettability and corrosion behavior of Mg-1Zn-CeO_2 composites targeted for biodegradable implant applications

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In the present research work, nano-CeO_2 ceramic particles (0, 1, 2 and 4 % by weight) were dispersed in Mg-1Zn alloy though stir casting route targeted for degradable implant applications. Microstructural

studies and X-ray diffraction analysis confirmed that the produced composites are free from any new phases. Wettability studies carried out by measuring the surface contact angles by using water as the solvent indicated higher surface energies for the composites due to the incorporated nano-CeO_2. From the electrochemical studies, carried out by using 3.5% NaCl solution as the electrolyte, better corrosion performance was observed for the composites with 1% and 2% reinforcement. When the CeO_2 content was increased to 4%, the corrosion resistance was observed as relatively decreased compared to the other composites due to the agglomeration of the reinforcements which accelerated the galvanic corrosion. However, compared with the base alloy (Mg-1Zn), composites have shown relatively better corrosion resistance. Within the composites, 2% CeO_2 was observed to be optimum quantity that decreased the galvanic corrosion effect. From the results, it is concluded that incorporating CeO_2 into Mg-1Zn alloy can enhance the degradation resistance of the alloy which is desirable in designing Mg based implants and lower amounts of CeO_2 is suggested to achieve higher benefits.

Keywords: Degradable implants, magnesium, CeO_2, composites, degradation,

ICAMSF-361

Evaluating the joint characteristics of dissimilar weld joints of Al6063-AZ31 Mg alloys produced by friction stir welding

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Joining dissimilar alloys by welding is technically challenging due to the heterogeneous chemical and physical properties. Evolution of friction stir welding (FSW) helped to address the complex issues involved in welding of dissimilar alloys. Among the non-ferrous alloys, aluminum (Al) and magnesium (Mg) alloys are the best-known light weight alloys widely used in the manufacturing industry. Hence, in the current work, two commercially available Al and Mg alloys (Al6063 and AZ31 Mg alloy) were selected and joined by FSW. The weld joint microstructure revealed mechanical mixing of both the base materials in the stir zone. X-ray diffraction studies confirmed the development of more intermetallic phase ($Mg_{17}Al_{12}$) within the weld zone due to the more solubility of Al. Hardness measurements across the weld joint revealed higher variations within the weld zone due to the presence of soft regions (base alloys) and hard regions (intermetallics). From the tensile tests, weld joint exhibited relatively similar strength (163.1 ± 11.5 MPa) to that of AZ31 Mg alloy (159.5 ± 9.3 MPa) and observed as lower compared with the Al6063 base alloy (188.3 ± 10.4 MPa). Weld joint exhibited relatively lower % of elongation compared with the base alloys. Presence of more intermetallic regions and mechanical mixing of materials in the weld zone are the reasons behind the brittle nature of the weld joint.

Keywords*:* dissimilar metals, aluminium, magnesium, FSW, mechanical mixing.

ICAMSF-362

Zn-MgO as novel biodegradable composite: mechanical performance and corrosion behavior

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In the current work, MgO reinforced Zn composites were produced by powder metallurgy route with varying fractions of MgO (1, 2 and 3% by weight) targeted for biomedical applications. Microstructures of the composites were studied and the phase analysis was done by X-ray diffraction analysis. After sintering, no new phases were identified in the composites. The constituting phases were characterized as remained Zn and MgO in the composites. Higher hardness (51 ± 3.3 HV0.1) was measured for Zn-2%MgO composites compared with the other samples. Increased fracture toughness was measured for the composites compared with base material. However, with the increased content of ZnO to 3%, no significant improvement was observed in the fracture toughness compare with Zn-2%MgO. The corrosion performance of the composites was assessed by electrochemical experiments by using simulated body fluids. From the electrochemical parameters, lower corrosion rate was recorded for composites and among them, Zn-1%MgO and Zn-2%MgO composites have shown similar corrosion response and relatively better performance than Zn-3%MgO. Form the weight loss measurements, lower degradation rate was also observed for the composites. The results suggest the promising role of adding MgO on improving the mechanical and corrosion performance of Zn composites.

Keywords: Zn implants, MgO, degradation, mechanical performance, corrosion.

ICAMSF-364

Metagenomic investigation revealed the microbial communities, genes and pathways of plastic biodegradation at landfill sites

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This study discusses the metagenomics-based approaches in identifying and characterizing the microbial communities of landfill sites towards plastic biodegradation. Interestingly, with diverse taxonomic groups inhabiting the plastic-rich soil, our study demonstrates the remarkable adaptability of microbes to use this new substrate as a carbon source. The spectroscopic analysis FTIR spectroscopic analysis of soil indicated degradation of plastic as perceived from the carbonyl index of 0.16, 0.72, and 0.44 at 0.6, 0.9 and 1.2 m depth, respectively. Similarly, water contact angles of 108.7degree, 99.7degree, 62.7 degree, and 77.8 degree of plastic pieces collected at 0.3, 0.6, 0.9, and 1.2 m depths respectively showed increased wettability and hydrophilicity of the plastic. Amplicon analysis of 16S and 18 S rRNA revealed

a high abundance of plastic-degrading bacterial groups, including Pseudomonas, Rhizobiales, Micrococcaceae, Chaetomium, Methyl ocaldum, Micromonosporaceae, Rhodothermaceae and fungi, including Trichoderma, Aspergillus, Candida at 0.9 m. The co-existence of specific microbial groups at different depths of landfill site indicates the importance of bacterial and fungal interactions for plastic. The whole metagenome analysis of soil sample at 0.9 m depth revealed a high abundance of genes encoding enzymes that participate in the biodegradation of PVC, polyethylene, PET, and polyurethane. Curation of the pathways related to the degradation of these materials provided a blueprint for plastic biodegradation in this ecosystem. Altogether, our study has highlighted the importance of microbial cooperation for the biodegradation of pollutants. Our metagenome-based investigation supports the current perception that consortia of fungi-bacteria are preferable to axenic cultures for effective bioremediation of the environment.

Keywords: Metagenomics, phylogeny, biodegradation, next generation sequencing

ICAMSF-367

Integrated Strategies for Sustainable Urban Bio-Waste Solutions

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The paper provides a comprehensive overview of urban bio-waste management, emphasizing the significance of effective strategies for handling organic waste in urban environments. It discusses the environmental and public health challenges associated with improper bio-waste disposal, including greenhouse gas emissions and contamination of water sources. The document highlights various integrated approaches to sustainable urban bio-waste management, showcasing successful case studies from cities such as San Francisco, Kamikatsu, Barcelona, and Curitiba. These case studies illustrate innovative practices, including community engagement, technological advancements, and regulatory frameworks that enhance waste reduction and resource recovery. The paper advocates for a shift towards a circular economy, emphasizing the economic and environmental benefits of efficient bio-waste management. It concludes by outlining future directions for research and policy development to improve urban bio-waste management practices globally.

Keywords: Urban waste; Bio-waste management; Circular economy, Environmental impact

ICAMSF-368

Enhanced Mechanical Properties of Carbon, Glass, and Hybrid fiber reinforced polymer Composites with Varied Fiber Orientations

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This study explores the mechanical properties of CF/epoxy, GF/epoxy, and hybrid CGF/epoxy composites, focusing on tensile and flexural behavior to develop a balanced composite material. The hybrid design uses CF's superior tensile and hardness properties alongside GF's excellent bending

strength. Two fiber orientations, (90/45/90/135/90) and (0/135/0/45/0), were used for each composite, tested according to ASTM D3039 standards. Experimental results from tensile tests on a UTM show that the (90/45/90/135/90) configuration exhibits higher tensile stress than the (0/135/0/45/0) configuration, while the three-point bending test revealed that (0/135/0/45/0) composites displayed higher flexural strength. Hybrid CGF/epoxy composites with (0/135/0/45/0) orientation exhibited superior flexural strength compared to CF/epoxy and GF/epoxy composites, making them suitable for applications demanding both tensile and bending capabilities.

Keywords*:* Mechanical properties, Carbon Fiber, Glass Fiber, Composite, fiber orientation.

ICAMSF-369

Fabrication and Characterization of Nano-Hybrid Aluminium Alloy Metal Matrix Composite

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The attractive features of Metal Matrix Composites (MMCs) have led to their considerable adaptation in a variety of commercial applications because of their beneficial qualities such as superior heat conductivity, oxidation stability, and high resistance. The present research work deals with the fabrication and characterization of aluminium (AA6063) alloy reinforced with marble dust powder and grapheme oxide to enhance its mechanical and thermal properties. The fabrication is done by stir casting process for its cost-effectiveness and sustainable method for large scale manufacturing. The uniform dispersion of the reinforcement particles throughout the matrix is performed by the technique of agitating the molten aluminium alloy with the reinforced particles. Composite samples were then examined under both cast and heat treatment settings to determine the physical parameters. Finally, the microstructure studies are performed by scanning electron microscopy (SEM) to speculate the distribution of the particles affecting the mechanical characteristics. The analysis was performed with and without reinforcement, considering the different weight percentage of AA6063 alloy and reinforcements.

Keywords: Hybrid Metal Matrix Composite (HMMC); Stir Casting; Marble Dust Powder; Graphene Oxide; Hardness Testing; Scanning Electron Microscope (SEM).

ICAMSF-370

Enactment Evaluation on Erection IoT Fractal Feeler Fabrication

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The RFID-Radio Frequency Identification technology for toll fee collection, goods management in chemical industries are emerging toward the “Internet of Things” converge in the research disciplines like, sensor networks, real-time localization, identification, which enabling the internet to fetch the physical things to real world with the help of web services. In general, the interconnection requires to construct the things with RFID structures, even for capacity of sensing. The constructions are assumed randomly with various mixed of bulk materials to create various computing capabilities. The RFID

structures are incorporated with small transmitters-receivers and are combined with both analog and digital functional features, the phenomenon of antennas and propagations. The information is transmitted from the nearby object to the reader and is digitally propagated via the interrogation zone, while the strength of backscattered power is ruled in analogue by the propagation modality. While propagating the signal, the orientation and mutual position among the tag and reader are important. Most of the researchers are concentrating and investigating to find the mitigation solutions for RFID tags proximity, especially focused on performance degradation in RFID link quality presence in dense movement. In the above-mentioned cases, the properties of data link are affected by the electromagnetic waves influenced in the interconnected systems. The RFID structures are imposed in single tag with an array ofentrenched microchips or, a single chip tag enclosed with mutual proximity. The macroscopic parameters governing the system responses come from the multi-port scattering framework. The proposed work aims in the direction of the designing and implementing RFID structures that optimize the size and power of the signals. This can be achieved by properly implementing impedance matching in the adjacent port network. The efficiency can be optimized by increasing electrical length for the specific applications. The work also extends to investigate the sensing responses of electromagnetic waves influencing on the location and orientation of reader and tag in nearby environment.

Keywords: RFID-Radio Frequency, Internet of Things, Electrical Length, Electromagnetic Waves.

ICAMSF-372

IoT Tentacle Feeler Fabrication

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The Radio Frequency Identification technology (RFID) for toll fee collection, goods management in chemical industries are emerging toward the “Internet of Things” converge in the research disciplines like, sensor networks, real-time localization, identification, which enabling the internet to fetch the physical things to real world with the help of web services. Novelty of the offered reader feeler is fabricated on a modified structure like fractal tree, where the angle between the two twigs is halved with each iteration. This design allows for a greater electrical length within a fixed physical space, enabling the structure to be miniaturized. In general, the interconnection requires toconstruct the things with RFID structures, even for capacity of sensing. The constructions are assumed randomly with various mixed of bulk materials to create various computing capabilities. The RFID structures are incorporated with small transmitters-receivers and are combined with both analog and digital functional features, i.e., the phenomenon of antennas and propagations. The information is transmitted from the nearby object to the reader and is digitally propagated via the interrogation zone, while the strength of backscattered power is ruled in analogue by the propagation modality. While propagating the signal, the orientation and mutual position among the tag and reader are important. Most of the researchers are concentrating and investigating to find the mitigation solutions for RFID tags proximity, especially focused on performance degradation in RFID link quality presence in dense movement. In the above-mentioned cases, the properties of data link are affected by the electromagnetic waves influenced in the interconnected systems. The RFID structures are imposed in solitary tag with an array of micro entrenched chips or, a single chip tag enclosed with mutual proximity. Macroscopic factors leading the structure responses come from the multi-port scattering framework. The proposed work aims in the direction of the designing and

implementing RFID structures that optimize the size and power of the signals. This can be achieved by properly implementing impedance matching in the adjacent port network. The efficiency can be optimized by increasing electrical length for the specific applications. Expand on the methodology used for simulations and measurements, including software versions and equipment specifications: The Tag and Reader antenna was designed and simulated using CST MWS 2010 and fabricated using FR-4 substrate. Subsequently finishing the simulation, investigation & fabrication was done. FR4 substrate was used. Simulation was ended based on waveguide port in transitory frequency domain solvers. The hands-on scenario of excitation was completed by means of SMA connectors soldered at the edge of the antenna and its characteristics was calibrated by an Agilent E8363B VNA. The work also extends to investigate the sensing responses of electromagnetic waves influencing on the location & orientation of reader and tag in nearby surroundings.

Keywords: Agilent E8363B VNA, Frequency Identification technology, Electromagnetic Waves

ICAMSF-373

Thermal management of electronics using CNT/BN loaded Phase change material-based heat sinks

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Thermal management of electronics has become a major challenge in the present scenario and use of phase change material (PCM) based hybrid heat sinks is a cost-effective method of cooling method. The hybrid heat sink can be effectively used for continuous and intermittent operation of the device. The present work focusses on the study of transient thermal performance of PCM based plate fin heat sink incorporated with a fan, for electronics cooling. The melting of PCM in hybrid heat sink was modelled in ANSYS FLUENT. Paraffin wax (melting point :58 - 60 o C) was used as the phase change material. Experiments were conducted with hybrid heat sink assembly with and without PCM with intermittent operation of fan based on the substrate temperature. Nanoparticles were mixed with PCM to improve the thermal conductivity of the PCM. Nanocomposite phase change materials (PCMs) were prepared by adding carbon nanotubes (CNTs) and Boron nitride (BN) nanoparticles at various loading concentrations. Thermo-physical properties of the nanocomposites PCMs were estimated for various concentrations at different temperatures. Nanocomposites PCMs were characterised using SEM (Scanning Electron Microscope), and the melting and solidification characteristics was studied by DSC (Differential Scanning Calorimetry). The thermal conductivity of nanocomposite PCMs were measured using transient plane source Hot disk apparatus. Experiments were conducted on hybrid heat sink with CNT/PCM and BN/PCM nanocomposites and a delay in fan ON time was obtained for BN/PCM nanocomposite loaded heat sink in comparison with conventional heat sink. However, delayed natural convection effect and decreased latent heat was observed for CNT/paraffin nanocomposite resultes in its faster melting of PCM. The hybrid heat sink with BN/PCM nanocomposite was operated in a continuous cycle and significant reduction in the operating time of the fan was observed. Energy savings due to reduced fan operation time for BN / PCM based hybrid heat sink was found to be more as compared to PCM integrated hybrid heat sink and conventional heat sink without PCM. The fan energy consumption of HS-BN/PCM and HS-PCM was found to be 25.1% and 18.75% lower than HS, at a power of 10W.

Keywords: (Phase change material (PCM), heat sinks, Paraffin wax, Nanoparticles, Carbon nanotubes (CNTs), Boron nitride (BN), Electronics cooling, Thermal management, Nanocomposites, Latent heat, HS-BN/PCM, HS-PCM, Natural convection)

ICAMSF-375

A Comprehensive and Detailed Review of Various Techniques for Enhancing the Performance of Solar Air Heater

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Energy is the fundamental force that drives life. It is essential for the growth, advancement, modernization, and economic development of any nation. To meet the rising energy demand and protect the planet from pollution, the global focus is shifting from fossil fuels to renewable energy sources. Among these emerging energy sources, solar power is becoming increasingly important. Solar air heaters are crucial for capturing solar energy, but their efficiency is hindered by low thermal performance. This inefficiency is primarily caused by the formation of a laminar sub-layer on the absorbing plate. This review article outlines various techniques for improving the efficiency of solar air heaters (SAHs) by disrupting the laminar sub-layer. It focuses on methods such as artificial roughness, jet impingement, and piezoelectric fans, all employed to enhance the performance of SAHs. This article also discusses the use of phase change materials (PCMs) to improve the performance and efficiency of SAHs. This review aims to update readers on recent advancements, challenges, and future prospects of solar air heaters (SAHs) as an alternative to fossil fuels. It concludes by evaluating the advantages and disadvantages of SAHs and offers recommendations for future research to expedite their commercial adoption.

Keyword: Solar air heater, Turbulators, Protrusion, Efficiency, Artificial roughness, Nusselt number, Thermal performance.

ICAMSF-377

Comprehensive Updated Review on the Application of Nanofluids in Various Heat Transfer Devices for Thermal Performance Enhancement

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Since the idea of distributing nano particles into a fluid was first proposed in the latter half of the 20th century, the field of nanofluids has attracted considerable attention. This is demonstrated by the rise in the number of studies on nanofluids that are published each year. The main reasons for the growing interest in nanofluids are their improved thermophysical characteristics and their adaptability to a variety of thermal applications, such as solar energy harvesting for renewable energy production or improving the efficiency of heat exchangers used in industry. This article reviews the advancements achieved in the preparation of nanofluids and their applications in a range of heat transfer devices, including heat exchangers, solar

collectors, refrigeration systems, radiators, thermal storage units, and electronic cooling. The efficiency and capacity of the solar energy storage and heat exchanger system can be improved by the use of nanofluids. In addition to providing readers with an update on current developments, this review will also address the future prospects and challenges facing nanofluids as the next generation of heat transfer fluids. Ultimately, an assessment of the benefits and drawbacks of nanofluids is provided, along with suggestions for more research that could spur the quick commercialization of nanofluids.

Keyword: Heat transfer, Nanofluids, Active methods, passive methods, twisted tapes, heat exchanger.

ICAMSF-380

Tribological study of Al-Cu alloy casted under magnetic field

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Al-Cu alloys, owing to their high specific strength and excellent mechanical properties, find application in many areas such as automobiles, aerospace, manufacturing etc. We have casted Al-10 wt.% Cu alloy under magnetic field. Micro indentation hardness tests were conducted on the casted alloy to characterize its mechanical properties i.e., hardness and elastic modulus. The alloy has shown improved mechanical properties in comparison to the alloy casted without magnetic field. The improved mechanical properties are attributed to grain refinement observed when casting is performed under magnetic field. In the present work we will present and discuss tribological study of the alloy casted under magnetic field. The tribological tests were performed in ball-on-disc geometry on a linear reciprocating tribometer. The tribological experiments were performed both at room and high temperature. Coefficient of friction and specific wear rate were investigated. Optical profilometry was utilized to estimate wear volume. Scanning Electron Microscopy (SEM) and Energy Dispersive Spectroscopy (EDS) were used to examine the surface morphology of worn and unworn specimens. Wear tracks on specimens have been analysed to understand the wear mechanism.

Keywords: Al-Cu alloy, Casting, Hardness, Tribology.

ICAMSF-381

A Comprehensive Study on the Mechanical Properties of Direct Metal Laser Sintered (Metal Additive Manufacturing) Components: Fatigue, Tensile Strength, and Hardness Analysis

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Direct Metal Laser Sintering (DMLS) has emerged as a groundbreaking additive manufacturing technique, offering exceptional potential for the fabrication of complex, high performance metal components. This advanced technology enables the production of intricate geometries that are often unachievable through traditional manufacturing methods. The present study undertakes a comprehensive investigation into the mechanical properties of components fabricated using the DMLS process, with a particular focus on fatigue behavior, tensile strength, and hardness. The research emphasizes the critical

role of key process parameters such as laser power, scan speed, and layer thickness in determining the mechanical performance of the final products. Variations in these parameters are systematically studied to assess their influence on microstructure and, consequently, the mechanical properties of the fabricated components. Rigorous testing methodologies are employed, including fatigue testing to evaluate cyclic loading behavior, tensile strength measurements to determine the material's resistance to deformation, and hardness assessments to gauge resistance to localized plastic deformation. The findings of this study establish clear correlations between the process parameters and the resulting mechanical properties, offering valuable insights into optimizing DMLS conditions for enhanced material performance. Notably, the research highlights the capability of DMLS to produce components that meet stringent industrial standards, making it a promising solution for demanding applications. This work underscores the potential of DMLS in critical sectors such as aerospace, automotive, and biomedical engineering, where reliability, precision, and superior mechanical performance are paramount. By addressing the challenges associated with process optimization, this study contributes to advancing the adoption of DMLS for high-value, performance-critical applications.

Keywords: Direct Metal Laser Sintering (DMLS), Process Parameters, Mechanical Properties, Fatigue Behavior, Advanced Manufacturing.

ICAMSF-382

Manufacturing feasibility studies on 3D printable SS/PLA composite filament extrusion and characterization with variable solid loading

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The increasing demand for composite 3D printing has driven significant interest in the development of advanced composite filaments for prototyping and tooling applications. This study focuses on the fabrication and processability of stainless steel (SS) 316L powder reinforced polylactic acid (PLA) composite filaments with solid loadings ranging from 2.5 wt. % to 10 wt. %, in 2.5 wt. % increments. A conical twin-screw extruder with four distinct heating zones was employed for melt compounding, followed by water cooling and filament spooling. The extrusion process was carefully optimized to achieve a consistent filament diameter of 1.75 ± 0.05 mm, with the highest extrusion temperature set at 170 °C. Optical microscopy analysis confirmed the uniform dispersion of SS 316L particles across all composite filaments, with particle counts increasing proportionally to the solid loading, validating the effectiveness of the compounding process. The distribution of the reinforcement was further quantified using the D index, which indicated near-homogeneous particle distribution, with values ranging between 0.25 and 0.3. Thermal stability was assessed through thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC), revealing that the composite filaments remained stable up to 350 °C, with melting points in the range of 150 °C to 160 °C. Rheological studies indicated shear thinning behaviour across all samples at shear rates above 50 (1/s), making them suitable for fused deposition modelling (FDM) 3D printing. Dynamic and frequency sweep tests showed extended linear viscoelastic regions and

liquid-like behaviour at 170 °C, while temperature sweeps suggested optimal printing temperatures between 200 °C and 210 °C. This comprehensive study provides valuable insights into the material behaviour and printability of SS 316L-filled PLA filaments.

Keywords: Composite filaments; Polylactic acid; Melt compounding; Fused deposition modelling; Melt rheology.

ICAMSF-383

Mechanical, Wear and Corrosion Behavior of Hot Pressed, Heat-Treated Al6061 Nano Composites

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This study explores the tribological, mechanical, and corrosion behavior of Al6061/ZrB_2 nano-composites, which were developed using the hot pressing (powder metallurgy (PM)) process and subjected to solutionizing treatment for 1 hour at 530°C, followed by quenching in water, and then artificially aged. By reinforcing Al6061 with ZrB_2 nanoparticles (0.5% to 2% by weight), the study evaluates improvements in microstructure, hardness, compression strength, wear resistance, and corrosion performance. FESEM and EDS analyses confirmed that the ZrB_2 particles were evenly distributed, leading to a denser structure with minimal porosity. The addition of ZrB_2 significantly enhanced hardness (reaching 78 HV) and compressive strength (up to 106.06 MPa). Wear testing under dry sliding conditions showed a notable decrease in wear rate as the ZrB_2 content increased, attributed to grain refinement and strong interfacial bonding. Corrosion studies in 3.5% NaCl solution demonstrated that heat-treated composites had better resistance to corrosion than Al6061, with the 2 wt.% ZrB_2 composite exhibiting the lowest corrosion rate. These findings highlight the potential of Al6061/ZrB_2 composites for high-performance applications in aerospace, automotive, and marine industries, where materials need to be strong, wear-resistant, and corrosion-resistant.

Keywords: Powder metallurgy (PM), heat treatment, hot pressed, mechanical properties, microstructural properties.

ICAMSF-384

Effect of Mercerization and Fibre Loading on the Physical and Mechanical Properties of Polyester/Sisal Fibre Composites

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The present work aims to study the effect of untreated sisal fibre and the influence of fibre treatment on polyester-based composites. Four categories of composites are prepared, comprising the first category with untreated sisal fibre (category A) and the other three categories with NaOH-treated fibre. The different concentrations of NaOH treatment used are 1 mole (category B), 2 moles (category C) and 3 moles (category D). Under each category, four composition samples were prepared with fibre loading from 2.5 wt. % to 10 wt. %. Micrographs show that the interfacial bonding between the fibre and polyester improves with treatment, though excessive treatment deteriorates the fibre surface thus decreasing the bonding between the two phases and showing decrement in the different properties. The void content and water absorption increase with fibre loading whereas, category C composites give the minimum values of both the properties. For category A composites, the tensile, flexural and compressive strength are improved by 21.1 %, 15.4 % and 13.5 % respectively, whereas hardness increases by 3.7 %. Among the different samples, category C composites deliver the best output. The tensile strength, flexural strength, compressive strength and hardness for category C composites are improved by 37.4 %, 30.6 %, 21.2 and 9.3 % respectively. The investigation shows that by judicially selecting the fibre loading and NaOH treatment concentration, one can achieve the best properties from polyester/sisal fibre composites.

Keywords: Polyester, Sisal fibre, Mercerization, Surface morphology, Physical Properties, Mechanical Properties.

ICAMSF-385

Development of Polymer Composites with Micro-Sized LD slag as a Filler Material: Mechanical and Tribological Characterization

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The present work studies the processing and characterization of waste LD Slag/polyester composites to achieve an environmentally friendly material. Samples are prepared for a range of 0-40 wt. % of LD Slag (LDS). Altogether, 9 samples are prepared i.e. one set of neat polyester and 8 sets of composites (5 wt. %, 10 wt. %, 15 wt. %, 20 wt. %, 25 wt. %, 30 wt.%, 35 wt.%, 40 wt. %). The developed materials are studied for their physical, mechanical and sliding wear properties. The micrographs of the filler and

composites and filler elemental composition are investigated in the work. The density of the polyester increases with LDS content and so does the water uptake rate. The maximum density measured is 1.468 g/cm3 and the water uptake percentage is 3.21 % for maximum filler loading. The best tensile and flexural strength is reported for 30 wt. % LDS. The maximum increment in both properties registered are 33.5 % and 28.1 %. The tensile and flexural modulus improves with LDS content due to an increase in stiffness. The maximum moduli are 3518 MPa and 4185 MPa for tensile and flexural loading respectively. Because of the increment in stiffness, the percentage elongation under tensile loading is reduced to 1.16 %. The compressive strength and hardness show an interesting increment showing an appreciable improvement of 26.2 % and 13.1 % for 40 wt. % filler loading. The sliding wear characteristics were studied by performing the experiment designed as per the L25 orthogonal array suggested by Taguchi's design of the experiment method. From the analysis, it was detected that the LDS loading influenced the specific wear rate the most, whereas normal load was the least influential factor. A model utilizing an artificial neural network is employed to envisage the specific wear rate at a broader range of parameters. The worn surface morphologies are analyzed to determine the wear mechanisms of the developed material under various situations.

***Keywords*:** Polyester, LD slag, Mechanical properties, Taguchi Method, Sliding wear behaviour, Artificial Neural Network.

ICAMSF-387

Sustainable Energy Solutions for Urban Open Spaces: Strategies for Resilient and Energy-Efficient Cities

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Urban open spaces, such as parks, plazas, and streetscapes, are essential for sustainable cities due to their social, economic, and environmental benefits. However, maintaining these spaces requires significant energy for lighting, water management, and infrastructure thus increasing urban energy demand. This paper explores the integration of renewable energy sources and energy-efficient technologies to enhance the sustainability, resilience, and environmental performance of urban open spaces. The study reviews various green energy strategies and technologies applicable to urban open spaces. It examines renewable energy sources, including solar, kinetic, wind, and geothermal, as well as energy-efficient solutions like LED lighting, smart sensors, and intelligent energy management systems. Moreover, case studies from global cities implementing these strategies are analyzed to highlight best practices and their effectiveness. Integrating renewable energy sources such as photovoltaic panels, small-scale wind turbines, and kinetic energy harvesting can significantly reduce reliance on conventional power grids in urban spaces. Case studies from cities like Barcelona, London, and Singapore highlight the effectiveness of these technologies in enhancing energy resilience. In Barcelona, solar ordinances and widespread photovoltaic installations contribute to a significant reduction in carbon emissions, while London's integration of small-scale wind turbines and kinetic energy harvesting in public spaces showcase the potential for diversified energy generation. Singapore, with its focus on smart urban planning, demonstrates how microgrids and AI-driven energy management optimize efficiency and distribution. Additionally, the implementation of smart lighting systems and rainwater harvesting further enhances urban sustainability by reducing both energy and water consumption. The success of these initiatives is strongly influenced by

policy support, financial incentives, and advancements in technology that facilitate seamless integration. However, challenges such as high initial investment costs, spatial constraints, and maintenance requirements remain critical considerations. Addressing these barriers through innovative financing models, adaptive urban policies, and technological advancements can further strengthen the impact of hybrid energy systems, paving the way for more resilient and self-sustaining cities. The study primarily relies on existing literature and case studies, which may not fully capture real-time challenges in implementation. Additionally, variations in climatic conditions, urban policies, and infrastructure constraints can impact the feasibility and scalability of these solutions across different regions. This paper contributes to the discourse on sustainable urban planning by systematically presenting various renewable energy strategies tailored for urban open spaces. It highlights the synergy between energy generation, efficiency, and intelligent management systems, offering insights into future city planning that prioritizes sustainability and resilience.

Keywords: Sustainable Energy, Urban Open Spaces, Renewable Energy, Energy Efficiency, Urban Planning, Resilient Cities.

ICAMSF-388

Fatigue Analysis of SiO2/Epoxy bonded Composite Joints Using FEM Pawan Kumar1, Sunil Kumar Gupta1, Kavita

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The addition of nanocomposite adhesives in adhesively bonded joints has gained significant attention in the aerospace, marine and automotive industries due to their ability to enhance mechanical properties while maintaining lightweight structures. This study investigates the effective elastic modulus of silica/epoxy nanocomposite adhesives and examines the influence of interphase thickness on the modulus. Additionally, fatigue analysis of adhesive joints is conducted using Finite Element Modelling (FEM). Experimental and analytical findings indicated that incorporating silica nanoparticles into the epoxy increases its elastic modulus with a maximum enhancement of 4% observed for 5wt% silica concentration. Furthermore, it was also observed that a decrease in interphase thickness resulted in an increase in the elastic modulus with 5nm thickness showing the highest improvement.

Keywords: Adhesive bonding, FEM, elastic modulus, fatigue, nanoparticles, nanocomposite adhesives

ICAMSF-391

Microplastic Pollution in Himalayan Lakes: Assessment, Risks, and Sustainable Remediation Strategies

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Microplastic contamination is a growing environmental concern for eco-sensitive Himalayan lakes, endangering biodiversity, water quality, and human communities. These high-altitude freshwater systems

are becoming more and more polluted as a result of human activity, tourism, glacier melt, and atmospheric deposition. However, evaluating microplastics in such isolated areas is fraught with difficulties, such as harsh weather, logistical limitations, and the need for specialist analytical methods like microscopy, and spectroscopy. This review examines the sources, pathways, and ecological risks of microplastics in Himalayan lakes, drawing comparisons with other sensitive aquatic ecosystems. It assesses current remediation technologies, classifying them into physical, chemical and biological techniques, and highlights new sustainable strategies including degradation aided by biofilms and solutions based on nanotechnology. The function of nanomaterials in the elimination of microplastics is specifically discussed, with case studies illustrating their effectiveness, especially in cold, high-UV environments. The bioaccumulation of microplastics in the Himalayan food web, the toxicity of plastic additives, and the possible long-term impacts on the environment and human health are the main topics of discussion regarding the ecotoxicological effects of microplastics. The review also examines policy frameworks that deal with microplastic pollution, emphasizing the need for better governance and monitoring as well as existing laws and community-driven mitigation initiatives. This work highlights the need for multidisciplinary research, regionally tailored remediation techniques, and a thorough evaluation of microplastic pollution in high-altitude lakes by identifying important research gaps. This study summarizes the state of art and promotes innovative, sustainable remediation methods, improved regulatory frameworks, and cooperative strategies to reduce microplastic contamination in the fragile freshwater ecosystems of the Himalayas.

Keywords: Himalayan Lakes, Microplastic Pollution, Nanotechnology, Remediation, Freshwater system, Biofilms

ICAMSF-392

Sustainable Energy Solutions in Building Construction: A Path to Energy-Efficient Architecture

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The building sector is one of the largest global energy consumers and contributors to carbon dioxide emissions. With rapid urbanization and infrastructure development, adopting sustainable energy solutions in construction has become essential to reduce environmental impact and enhance energy efficiency. This paper analyzes key strategies for sustainable energy consumption in buildings, focusing on renewable energy integration, energy-efficient materials, modern construction technologies, and passive design principles. The transition toward net-zero energy buildings is central to reducing carbon footprints and dependency on fossil fuels. The study reviews various sustainable energy strategies employed in building design and construction. It examines passive design approaches such as natural ventilation, thermal mass and optimal building orientation, alongside active energy solutions like solar photovoltaics, wind, and geothermal energy systems. Additionally, it explores modern technologies such as AI-driven automation, IoT-enabled energy management, and Building Information Modeling (BIM) to enhance real-time energy monitoring. Case studies of successful sustainable buildings worldwide are analyzed to demonstrate the effectiveness of these strategies. The study highlights that integrating passive design strategies significantly reduces the need for artificial heating and cooling, thereby improving overall energy efficiency. Renewable energy systems provide clean, decentralized power, while adaptive facades, smart

glazing, and high-performance insulation enhance thermal comfort and reduce energy loss. The case studies of The Edge (Amsterdam), the Bullitt Center (Seattle), Bosco Verticale (Milan), the CII-Sohrabji Godrej Green Business Centre (Hyderabad), and the BedZED housing project (London) illustrate the successful implementation of sustainable energy solutions across various climates and regulatory environments. Despite the advantages, challenges such as high initial costs, regulatory barriers, and technological constraints hinder the widespread adoption of sustainable energy solutions in buildings. The feasibility of implementing these strategies varies based on economic and policy frameworks, limiting scalability in certain regions. Additionally, the long-term performance and maintenance of advanced energy-efficient technologies require further research and adaptation. This paper contributes to the discourse on sustainable architecture by systematically presenting an integrated approach to energy efficiency in the building sector. It underscores the necessity of innovation, regulatory support, and interdisciplinary collaboration to foster a resilient and energy-efficient built environment. By emphasizing smart technologies, renewable energy adoption, and passive-active energy strategies, the study advocates for a transformative shift toward low-carbon and climate-responsive construction practices.

Keywords: Sustainable energy solutions, Net-zero energy buildings, Passive design strategies, Renewable energy integration, Energy-efficient materials, Smart building technologies, Climate-responsive architecture.

ICAMSF-393

Microbial Biodegradation of Polystyrene Microplastics: Isolation, Characterization and Degradation Efficiency of a River-Isolated Bacterium

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Plastic pollution is a growing environmental concern, with polystyrene (PS) microplastics posing a significant threat due to their persistence and resistance to natural degradation. This study aimed to isolate and characterize a PS-degrading bacterium from polluted river water. Bacterial diversity was initially observed on nutrient agar (NA), and selected isolates were transferred to a KBM medium supplemented with PS microplastics as the sole carbon source. The degradation efficiency was evaluated through weight loss measurements, biofilm formation using the crystal violet assay, and Fourier-transform infrared spectroscopy (FTIR) over a period of 30 days. The bacterium exhibited a PS weight loss of 4.11%, with a calculated half-life of 248.01 days. Growth analysis indicated an increase in optical density at 600 nm to 0.80, while the pH remained stable at 7.16, suggesting microbial adaptation to PS as a carbon source. FTIR spectra revealed peak shifts and structural modifications in PS particles, confirming microbial degradation. These findings indicate that the isolated bacterium possesses significant potential for PS biodegradation, contributing to the removal of microplastics from polluted environments. Further studies are needed to elucidate the enzymatic pathways involved and optimize degradation conditions for enhanced efficiency. Understanding these mechanisms could facilitate large-scale bioremediation applications, providing a sustainable and eco-friendly approach to mitigating PS microplastic pollution in aquatic ecosystems.

Keywords: biofilm, biodegradation, degradation, microplastics, polystyrene

ICAMSF-397

A study on the mechanical characteristics of epoxy-al2o3 / mgo particals spread on aluminium substrates

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This investigation embarks upon the mechanical characteristics evaluation of epoxy reinforced with aluminum oxide (Al2O3) and magnesium oxide (MgO) smeared on aluminum substrates. Epoxy resins are widely recognized for their excellent adhesion, mechanical strength, and resistance to material degradation, making them suitable for environmental protection. The incorporation of Al2O3 and MgO particles into epoxy matrices has been reported to enhance the mechanical characteristics of the components. The mechanical properties (Tensile Strength & Flexural Strength) of the components developed using Hand layup method have been evaluated using UTM as per the ASTM standard. Apart from this, the hardness, roughness, composition and damage morphological studies have been carried out using Shore D durometer, surface roughness gauge, Fourier Transform Infrared spectroscopy and Scanning Electron Microscopy (SEM) / Transmission Electron Microscopy (TEM)/Energy Dispersive X-ray analysis (EDAX) receptively. This paper presents a comprehensive analysis of the mechanical performance of these composites focusing on the Mechanical properties and correlating them Tensile / Flexural damage features.

Keywords: Epoxy composites, Aluminum Substrates, Alumina, Magnesia, Mechanical Properties, SEM

ICAMSF-399

An investigation on water hyacinth as a renewable energy source for biogas

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Natural biogas is a sustainable, renewable, nontoxic eco-friendly substitutes and their industrial production is widely used in agricultural, food, environmental industries, and so on. Water Hyacinth (natural) which can be utilized to produce biofuel plays a very important role. The optimum benefit could be achieved from the by-products of water hyacinth with minimum processing. Water hyacinth can be considered as the best alternative to cope up with the progression of regional and global environmental change as the depletion of fossil fuel depletion. The study indicated that discontinuous-type plant could

produce biogas from a mix of water hyacinth and fresh rumen residue to satisfy communal cooking energy needs. The project has reviewed the water hyacinth work carried out till date which can also be utilized for the water treatment process and removal of heavy metals from the effluent or waste water because of appreciable absorption capacity it possesses. In this paper, a computer simulated mathematical model has been prepared through which it can be easily transplanted into biofuels due to its low lignin content and high growth rate.

Keywords: Water Hyacinth, bio-gas production, pH Value, computer simulation, mathematical modelling.

ICAMSF-401

Enhancing Surface Wear Resistance of Aluminum and Magnesium Alloys through Friction Stir Processed Surface Composites: A Critical Review

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Developing surface meal matrix composites by friction stir processing (FSP) is a well-studied area in the surface engineering of metals and alloys. Producing the composites within the solid state is advantageous. It eliminates several issues encountered in liquid state methods while developing composites of highly reactive metals. In addition to incorporating the secondary phases into the surface, fine grain structure also can be produced at the surface which is an additional benefit with FSP. Surface properties such as hardness, wear resistance and corrosion resistance of aluminium and magnesium alloys are significantly altered by producing surface composites. The current review provides a comprehensive summary of recent developments in adopting FSP to produce surface composites of aluminium and magnesium alloys. The influencing process parameters, different combinations of matrix and reinforcing materials and the corresponding effect on the surface properties are critically discussed. The challenges and future scope in surface composites by FSP are also discussed.

***Keywords**:* Composites, FSP, Aluminium, Magnesium, Surface Engineering

ICAMSF-404

Tensile and Buckling Strength Evaluation of Basalt/Carbon Hybrid Laminates with Hole Arrangements

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We can have various combinations of composites to achieve the required mechanical properties. The use of fiber-reinforced composites in aero components has increased tremendously in the recent past due to their huge advantages. The favourable attributes, such as a high strength-to-weight and stiffness ratio, make them the preferred choice for numerous aircraft structural components, including the cockpit, wings, and empennage etc. Further, in structural assemblies, fastening two components by bolting or riveting is quite common. Similarly, in aero panel's bolting or riveting is practised for joining structural components. Thus, multiple holes in different patterns are done on laminates for joining purposes. These holes in turn cause high stress concentration gradients at the vicinity of their edges. The hole edges interact with themselves or with the laminate's edges, to further increase the stress gradient in their vicinity. It is also to note that holes' arrangements are present in different orientations and diameters. Hence, the present study focuses on combinations of composite laminates with hole arrangements and its tensile and buckling strength evaluation. Mainly, basalt composites are suitable, functional, and favourable alternative for carbon composites. The main objective of this work was set to study the influence of holes and hole hole distances on material strength. Experimental testing was used in this study to analyse the mechanical properties of basalt and carbon composites. For the experimental part, tensile and buckling tests were carried out and further failure morphology was studied. Hand lay-up fabrication was used to fabricate basalt/carbon epoxy laminates. Basalt fabric was stacked with carbon at different fibre orientation of [0º/45º/-45º] and testing was done. On the other hand, the number of holes and the orientation of holes on the specimens varied to study the influence of holes on material strength. The ASTM test standard deployed were D5766 for tensile tests and STP18273S for buckling testing. For numerical part of the study, ANSYS software was used to simulate the tensile tests which will enable the study of stress concentration around the holes. Similar testing standard was used for tensile test simulation. From this study, basalt epoxy laminates have shown a significant drop in mechanical strength with an increase in the number of holes. In terms of hole-hole distances, the mechanical strength improves as the hole-hole distances increase. This study concludes that the closer the holes to each other, the higher the stress concentration around the hole, hence reducing the mechanical strength.
Keywords: Basalt laminates, Carbon laminates, Tensile Strength, Buckling and Stress Analysis

ICAMSF-405

Comparative Study of Oxidation and Hot Corrosion Resistance of Stellite 6-Coated and Uncoated T91 Steel

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Ferritic steels are widely used to construct the superheater tubes of boilers present in power plants. Due to the usage of variety fuels, these superheated tubes get corroded very easily which account for major loss and unwanted shutdowns. The corrosion will reduce by reducing the temperature which can further

reduce the efficiency of boilers. Hence, it is necessary to provide some measure to protect the components from corrosive species. To obviate this problem, it is suggested to increase the lifespan of the material by tailoring the surface properties. Thermal spray coatings are widely used to deposited coating on the components used in extreme environment. Variety of coating powders are available which can be deposited as per the requirements. However, it is necessary to check the sustainability of coating with the specific alloy. Therefore, in the present investigation, degradation of Detonation gun sprayed Stellite 6 coating deposited on T91 steel was reported under simulated oxidation and hot corrosion environment at 900°C. It was observed that the bare specimen undergone huge spallation followed by formation of porous and massive oxide. Although the coating was successfully deposited and has increased the corrosion resistance of the steel. However, the major cracks were observed on the surface of the coated specimens.

Keywords*:* Oxidation, Hot corrosion, Boiler steel, Stellite 6 coating

ICAMSF-406

Microstructural and Mechanical Characterization of Nanostructured TBCs on Superni-718

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Thermal barrier coatings (TBCs) play a critical role in protecting components exposed to high temperatures in aerospace and energy applications. These coatings enhance the efficiency and longevity of engine components by mitigating thermal stress, preventing oxidation, and reducing corrosion. Nanostructured TBCs were deposited into nickel-based superalloy substrates using DC magnetron sputtering, a technique that enables precise control over microstructure and composition to improve coating performance. Optimization of sputtering parameters resulted in coatings with strong adhesion, low porosity, and high thermal stability. Structural and mechanical properties were analysed using scanning electron microscopy (SEM), X-ray diffraction (XRD), and nanoindentation. SEM analysis revealed a columnar microstructure that enhances thermal insulation and mechanical strength. XRD confirmed phase stability, while nanoindentation measurements demonstrated superior hardness and resistance to mechanical degradation. Thermal performance was evaluated at three different temperatures to assess hardness and structural integrity under varying thermal conditions. The results provided insights into the coatings' ability to withstand high-temperature exposure while maintaining mechanical performance. Optimizations in the deposition process led to improved coating properties, ensuring greater protection against thermal degradation. Enhanced deposition techniques contribute to the development of coatings with superior reliability, making them well-suited for gas turbines, jet engines, and other high-temperature applications. These advancements support the long-term durability of critical components and improve overall system efficiency in demanding operational environments.

Keywords: Thermal Barrier Coatings, DC Magnetron Sputtering, Nanostructured Coatings, Nickel-Based Superalloy, SEM, XRD, Nanoindentation, Microstructural Analysis

ICAMSF-408

Biomass-Derived Nanocellulose Mediated Flexible Elastomeric Nanocomposites

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Conventional rubber manufacturing predominantly utilizes petroleum-derived additives, such as carbon black (CB), contributing to ecological concerns. This research focuses on addressing these issues by partially substituting CB with biomass-sourced nanocellulose, derived from wheat straw—a readily available agricultural residue—thereby promoting resource sustainability. Nanocellulose fibers (CNF) were isolated via chemo-mechanical processing of wheat straw biomass and subsequently integrated into elastomeric matrices to fabricate flexible nanocomposites. Structural analysis verified the successful nanoscale defibrillation of cellulose into CNF. The nanocomposites underwent extensive characterization to assess their structure-property relationships, vulcanization kinetics, thermal resilience, and mechanical performance under static and dynamic conditions. The hybrid incorporation of CNF and CB demonstrated synergistic effects, yielding notable enhancements in tensile strength, strain energy density, and dynamic properties such as reduced rolling resistance, improved traction, and diminished stress-softening. Remarkably, up to 15 phr of CB could be replaced without compromising performance. Crucially, these advancements were achieved without surface functionalization of CNF, underscoring its inherent compatibility and reinforcing capability in elastomeric systems. This study highlights the viability of biomass-derived nanocellulose as a sustainable alternative to petroleum based fillers, paving the way for eco-conscious, high-performance elastomeric nanocomposites that align with circular economy principles by valorizing agricultural waste.

Keywords: Nanocellulose, carbon black, chemo-mechanical process

ICAMSF-409

Wear Performance of Polymer Composites Reinforced with Wood Apple Shell Particles

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The growing demand for sustainable materials has encouraged the use of agricultural waste to develop environmentally friendly products. This study explores the potential of wood apple shell (Limonia acidissima), a byproduct from the food industry, as reinforcement in polymer composites. The shell particles are processed through ball milling to obtain the required particle size and incorporated into a polymer matrix in different weight fractions (0, 5, 10, 15, and 20 wt.%) using the hand lay-up method. A pin-on-disc test is conducted to examine the abrasive wear behaviour of the composites. The Taguchi experimental design is used to determine the optimal parameters for achieving the lowest specific wear rate. Response table analysis identifies the key parameters influencing wear resistance. Additionally,

surface morphology analysis of the worn surfaces provides insights into the predominant wear mechanisms affecting material loss. The results demonstrate the effectiveness of wood apple shell particles in enhancing wear resistance, offering a sustainable alternative for composite reinforcement. This study emphasizes the benefits of agricultural waste utilization in material development, reducing waste while promoting sustainable industrial applications.

Keywords: Agro-waste Filler; Particle Reinforced Composites; Polymer Composites; Abrasive Wear; Taguchi Experimental Design.

ICAMSF-410

Analysis of the Drilling Performances of AISI 304 Stainless Steel

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AISI 304 stainless steel has many applications like households, industrial etc. because of its high corrosion resistance and toughness. Based on its application, the current study analyses the drilling performances of AISI 304 stainless steel in terms of cutting time, cutting temperature and surface roughness and surface morphology of the drilled hole surface. Spindle speed, feed rate and drill bit diameter are considered as the input factors. Analysis of variance (ANOVA) confirmed that the effect of spindle speed is dominant on cutting time. Similarly, spindle speed and feed rate is found significant on cutting temperature and spindle speed, feed rate and drill bit diameter on surface roughness. High spindle speed along with high feed rate take less time to drill a hole, whereas it increases the temperature of the hole surface. Other hand, at medium spindle speed with high feed rate, the hole surface finish is better. The coefficients of determination for cutting time, cutting temperature, and surface roughness found as 92.2%, 97.5%, and 96.2%, respectively suggested more precise and reliable predictions during the drilling process. Field emission scanning electron microscope (FESEM) analysis revealed the formation of cracks and presence of carbide particles at the hole surface. Morphological study showed that at higher spindle speeds, the surface finish of the hole surface is better than at lower spindles because of the improved grain refinement.

Keywords: Drilling; ANOVA; S/N ratio; Surface morphology

ICAMSF-411

Experimental Investigation of Methane Generation from Mixed Kitchen Waste

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Biogas appears to be a promising source of cleaner fuel for the future. The present study is performed with different food to microbes (F/M) ratio of mixed kitchen waste (MKW) for the maximum production of methane gas. A constant amount of 104.23g cow dung is added to the kitchen waste to provide the required microbes. The experimental condition for F/M ratio of 0.5, 1.0, 1.5, 2.0, and 2.5. The experiments are conducted for 44 days continuously to investigate the production of methane. The tests viz. volatile solid (VS), volatile fatty acid (VFA), and chemical oxygen demand (COD) are carried out to

determine the methane gas production on daily basis. It is observed that the highest volume of methane obtained as 3906 ml for the condition of F/M ratio of 0.5. The above is followed by 1.0 and 1.5 of F/M ratio. Chemistry of methane generation in aerobic conditions in landfills was also investigated in this study.

Keyword: Biochemical methane potential, chemical oxygen demand, food to microbe ratio, volatile fatty acid

ICAMSF-412

Defluoridation using Adsorption: A Review on Batch analysis parameters, kinetics, isotherms, activation energy and thermodynamics

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Fluoride is one of the common contaminants present in groundwater and in waterbodies in general. It can create serious health hazards from excessive ingestion (>1.5 mg/L). There are several defluoridation methods like membrane separation, ion exchange etc. to remove fluoride from drinking water. However, because of the high processing costs, such technologies are not always suitable for developing countries. As a result, environmentally friendly and low-cost technology is in high demand. Adsorption is one such low-cost method that is successful at removing fluoride. This review article reports for the use adsorption and various adsorbents for the defluoridation of contaminated water. Observations have been reported for batch studies done by several researchers for effect of various parameter like initial concentration, temperature, contact time, pH, stirring rate on the removal of fluoride using adsorption from aqueous solution. Reviews suggests that adsorptioncan be effectively applied for the defluoridation which can be supported from the fact that most of the researches done follows Pseudo second order kinetic model which suggests the suitability of the technique. Isotherm studies reveal that most of the adsorption follows either Langmuir or Freundlich models. Overall, it was inferred adsorption is an effective tool for defluoridation of contaminated waters.

Keywords: Adsorption, Defluoridation, Activation Energy, Point of zero charge (pHpzc), Adsorption kinetics, Isotherm equilibrium

ICAMSF-414

New insight on thermal decomposition of perfluorooctanoic acid (PFOA) from wastewater: Mechanism and controlling factors

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Perfluorooctanoic acid (PFOA) occurrence in water bodies is formed globally and it poses a serious detrimental effect on health of organisms. Globally, there has been much discussion on how to effectively

remove the persistent organic pollutant PFOA. Removing PFOA fully and effectively using conventional physical, chemical, and biological approaches is challenging, expensive, and prone to secondary pollution. Using certain technology can be challenging. Some technologies There are challenges to using some technologies. As a result, efforts have been made to find greener and more effective degrading technologies. It has been demonstrated that photochemical degradation is a cheaper, effective, and environmentally friendly method of removing PFOA from water. There are numerous chances and potential for the real breakdown of PFOA with photocatalytic degradation technology. The mainstream of PFOA research has been carried out in perfect lab settings at levels higher than those seen in actual wastewater. The mechanism and kinetics of PFOA degradation in various systems, as well as the impact of important variables on the photo-oxidative degradation and defluoridation process, such as system pH and photocatalyst concentration, are summarized in this paper along with the current state of research on the photo-oxidative degradation of PFOA. The current issues with PFOA photodegradation technology are also discussed, along with potential future research areas. This assessment is a supportive resource for PFOA pollution control technology development in the future.
Keywords: Perfluorooctanoic acid (PFOA); degradation; catalytic activity; controlling factors; removal mechanism

ICAMSF-415

An Evidence Theory Approach to the Removal of Nano and Microplastic Pollution: Exploring Efficient Water Purification Methods

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Plastic pollution, particularly in the form of nano and microplastics, represents a substantial threat to aquatic ecosystems and human health. With the increasingly severe threat of plastic pollution in aquatic systems, this paper studies various techniques for water purification of plastic from nano and microplastics. Different treatment methods, such as physical, chemical and biological methods have been studied in many studies in terms of efficiency, prospects and environmental risk. The novelty of this work is the integration of the proposed treatment methods into the framework of Evidence Theory. Through this theoretical perspective, this study not only evaluates the treatment efficiency of the techniques but also provides a comprehensive perspective of their use in varied pollution contexts. The model offers an integrated resource for elucidating the evolution of the potency and preponderance of plastics pollutants in waterbodies. Studying such a range also allows for a more comprehensive and detailed review of the literature, showing us in what ways these methods can be refined and used together for water quality management with better efficiency. This research provides a best diverse and multidimensional approach of assessment for treatment technologies, which significantly helps in sustaining the green movement and offers a qualitative contribution towards environmental protection and sustainability.
Keywords: Plastic pollution; Water; Nano and Microplastics; Evidence Theory; Purification methods.

ICAMSF-416

Microplastics and Nanoplastics in Aquatic Ecosystem: Advances in Detection, Transport and Ecological Impacts

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Microplastics and Nanoplastics (MPs and NPs) have emerged as pervasive pollutants in aquatic ecosystems, with growing concerns over their detection, sources, and ecological impacts. Despite increasing research efforts, gaps remains in understanding their precise fate, transport and long -term consequences particularly within benthic ecosystem. This study aims to provide a comprehensive assessment of recent advancements in methodologies for detecting MPs and NPs in water and soil, highlighting innovative analytical techniques. . A key focus is placed on their influence on the fate and mobility of aquatic fauna, particularly benthic macroinvertebrates. Additionally, the study explores novel sources of MPs and NP, shedding light on their diverse origins and pathways into aquatic systems. A systematic literature review was conducted, to analyze recent studies on MPs and NPs detection techniques, sources, and environmental impacts.The study examines how MPs and NPs affect the physiology, behavior, and survival of benthic macrofauna, emphasizing their potential role in physicochemical interactions, biofouling, and biotransportation within aquatic environments. Furthermore, the utility of MPs and NPs as pollution tracers and their role in contaminant transport are discussed in the context of environmental modeling. By integrating recent findings, this review underscores the need for multidisciplinary approaches to assess the ecological risks of MPs and NPs and to develop mitigation strategies to protect aquatic biodiversity.

Keyword: Microplastic, Nanoplastics, Contaminants, Plastic Pollution, Benthic Macroinvertebrates.

ICAMSF-418

Influence of Titanium-diboride on Mechanical properties and Tribological performance of centrifugal cast TiB2-Al7075 functionally-graded-composites

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Automotive aluminum liners usually have lower wear performance compared to conventional iron liners. Developing graded aluminum composites could address this issue through their varying microstructure and mechanical properties. Thus, Al7075 cylindrical functionally-graded-composite-materials (FGMs) with 5 and 7.5 wt.% TiB2 content were produced through horizontal centrifugal casting process. The FGMs displayed microstructural gradient including a variation in hardness and tensile strength from their inner to outer region. X- ray diffraction analysis confirmed presence of TiB2 in aluminum in addition to the Ti3Al phase. The hardness increased by 27% and 32% besides the strength shown 47% and 58% enhancement from the inner region to outer region for 5 and 7.5wt.% TiB2-Al7075 FGMs respectively. Moreover, systematic dry sliding tests were performed at varying speeds (100–600 rpm) under 5 and 15N load for 2000m distance at the inner and outer surface of the FGMs. Wear rates reduced between 20% to 40% for the inner surface to the outer surface and different wt.% of reinforcement content. Primarily wear-rates were influenced by sliding speed, load and reinforcement quantity in the composites.

Additional analysis for the worn surface revealed instances of primary abrasion and dense serrations at lower speeds (< 200 rpm) whereas surface cracks, delamination and pits prevailed at increased load (15N) conditions.

Keywords: Functionally graded material; Centrifugal casting; Al7075; Titanium diboride; Wear.

ICAMSF-419

Predicting the Best Mix Design for Paver Blocks Using Machine Learning Models

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In recent years, the construction industry has made remarkable strides in improving material quality and optimizing processes. Paver blocks, widely used for paving roads, sidewalks, and parking lots, have become increasingly popular for their durability, affordability, and adaptability. The quality and performance of these blocks depend heavily on the mix design, which combines cement, aggregates, water, and other additives. Finding the ideal mix design is essential to achieve strength, durability, and cost-effectiveness, but the traditional trial-and-error approach to optimization can be tedious and resource-intensive. Machine learning (ML) presents an exciting opportunity to revolutionize this process. By analyzing past data and identifying patterns, ML algorithms can predict the best mix proportions for paver blocks with remarkable accuracy, eliminating much of the guesswork. This study evaluates the performance of optimized LightGBM (LGBM) and CatBoost (CATB) models in predicting key material properties, including Compressive Strength, Flexural Strength, Water Absorption, and Abrasion Resistance. GridSearchCV was employed to fine-tune hyperparameters, leading to noticeable improvements in model accuracy. The optimized CATB model consistently outperforms LGBM, achieving significantly higher R^2 values and lower error metrics (MSE, RMSE, MAE, RMSLE, and MAPE) across all features. Particularly, CATB demonstrates near-perfect predictive capability for Compressive Strength ($R^2 = 0.96$), Flexural Strength ($R^2 = 0.98$), and Water Absorption ($R^2 = 0.93$), with minimal errors, highlighting its robustness. In contrast, LGBM shows moderate improvements but remains less effective in variance explanation and error minimization. The findings confirm CATB's superiority in predictive modelling, making it a more reliable choice for material property estimation.

Keywords: LightGBM, CatBoost, GridSearchCV, Performance Evaluation

ICAMSF-420

Effect of aging duration on the tribological characteristics of the LM25 - SiC - TIO_2 hybrid composite

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The present study investigates the effect of aging duration on the tribological characteristics of LM25 aluminum alloy reinforced with SiC and TiO_2 ceramic particles. A hybrid metal matrix composite (MMC) was fabricated using the stir casting technique, incorporating 7.5 wt.% SiC and 2.5 wt.% TiO_2 as reinforcements. The composite was subjected to solution treatment at 550°C for 4 hours, followed by artificial aging at 250°C for 4, 6, and 8 hours. Microstructural analysis using optical microscopy and X-ray diffraction (XRD) confirmed the uniform dispersion of ceramic reinforcements. Hardness testing revealed that the 6-hour aged composite exhibited the highest hardness due to optimized precipitation hardening of Si particles. Tribological performance was assessed using a pin-on-disc tribometer under varying loads (20–60 N) and a sliding velocity of 2 m/s. The 6-hour aged composite demonstrated superior wear resistance, attributed to the synergistic effect of reinforcement particles and aging-induced microstructural modifications. Worn surface analysis using high-resolution scanning electron microscopy (HRSEM) identified abrasion and delamination as the dominant wear mechanisms. The findings indicate that aging duration significantly influences the mechanical and tribological performance of LM25-SiC-TiO_2 hybrid MMCs, with 6-hour aging providing optimal properties for wear-resistant applications.

Keywords: SiC and TiO_2, high-resolution scanning, Worn surface analysis, hybrid MMCs

ICAMSF-421

Development and performance analysis of porous Mg-Zn scaffold for bone-tissue engineering applications

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Magnesium (Mg) alloys have gained significant attention for biomedical applications owing to their biodegradability and mechanical properties. While extensive research has been conducted on solid Mg alloys, studies on the mechanical, electrochemical, and biological performance of porous Mg alloys remain limited. Due to the highly reactive nature of magnesium, the process of alloying is challenging, and the creation of porous alloy structures presents additional difficulties. In this study, porous Mg-Zn scaffolds have been successfully developed using a powder metallurgy process with an eco-friendly

approach. Mg and Zn powders were initially ball-milled for uniform mixing, followed by the addition of stearic acid to control porosity. After compaction, the pellets were sintered in an inert atmosphere at 550°C, ensuring complete removal of stearic acid and the formation of a porous structure. The scaffolds were characterized using X-ray diffraction (XRD) for phase analysis, optical microscopy and scanning electron microscopy (SEM) for microstructural evaluation, and energy-dispersive spectroscopy (EDS) for elemental analysis, confirming the presence of Mg and Zn in the desired composition. Electrochemical performance was assessed through potentiodynamic polarization and electrochemical impedance spectroscopy (EIS), revealing that corrosion resistance was significantly influenced by porosity. Mechanical properties, including micro hardness, were evaluated, demonstrating values within the acceptable range for bone tissue engineering applications. Finally, in vitro biocompatibility was assessed using MTT and DAPI assays, confirming excellent cell viability and attachment. The results indicate that the developed porous Mg-Zn scaffolds exhibit significant potential for bone tissue engineering applications.

Keywords: Mg alloy, Porosity, Powder metallurgy, Corrosion, Bone-Tissue engineering

ICAMSF-422

Impact of Co-Firing Stubble Pellets with Coal on Ash Behaviour, Disposal and Utilisation: A Comprehensive Review

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Co-firing stubble pellets with coal presents a sustainable energy solution that addresses environmental, economic and operational challenges. In regions like Northern India, the widespread practice of crop stubble burning contributes to severe air pollution, including smog, particulate matter, and CO2 emissions. Integrating stubble pellets into coal fired power plants can significantly reduce carbon and sulfur emissions, ensuring compliance with environmental regulations while promoting cleaner energy production. Additionally, co-firing help reduce the coal dependency and generates employment opportunities for farmers and local workers through stubble collection and pellet formation. However, several challenges must be addressed for effective co-firing. Achieving the optimum pellet-to-coal ratio is crucial to ensure suitable combustion characteristics while maintaining compatibility with existing power plant equipment. Moreover, the differences in ash composition —stubble pellet ash being rich in K_2O and Cl, while coal ash primarily contains SiO_2, Al_2O_3, and Fe_2O_3—lead to the formation of new mineral phases during combustion. This alters the ash behavior, including slag formation, melting temperatures and corrosion tendencies. Consequently, the disposal and utilisation of co-firing ash requires a tailored approach. Despite the potential benefits, limited research exists on the properties, handling, and utilization of ash generated from co-firing various stubble crops in different blending proportions. This paper presents a comprehensive review on studies on co-firing ash, focusing on its impact on slag formation, corrosion characteristics, and challenges related to ash conveying, disposal and utilisation.

Keywords: Stubble burning, co-firing, stubble pellet ash, corrosion, slag formation

ICAMSF-423

Investigating Photocatalytic Efficiency of Fe-based Moringa oleifera Seeds Derived nanoparticles for Methyl Blue Dye degradation

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Rapid industrialization and urban development placed immense pressure on environmental resources. In particular, industries that discharges effluents laden with recalcitrant substances pose significant challenges to the sustainability of industrial clusters. Among these concerns, the treatment of dye-bearing industrial effluents remains a major environmental issue due to high concentration of pollutants, especially synthetic dyes. Moringa oleifera and its parts are well known for its coagulative and adsorptive properties, however investigations on its derived nanoparticles are much limited in literature, particularly under solar light irradiation. In this context, this study investigates the photocatalytic degradation of methyl blue dye in presence of Fe-based Moringa oleifera Seeds (MOS) derived nanoparticles. The synthesized nanoparticles (Fe-MOS-NPs) were characterized using X-ray diffraction (XRD), scanning electron microscopy (SEM), UV-Visible spectroscopy, and Fourier-transform infrared spectroscopy (FTIR), confirming their nanoscale structure and photocatalytic properties. The blank and positive control studies were conducted, to examine the effect of optimized operational parameters e.g., pH of dye solution, initial dye concentration, dose of nanoparticles, contact time/irradiation time etc. Further, recyclability of synthesized nanoparticles was assessed to understand the economics of this process. Overall, the finding of this study revealed that Moringa oleifera extract worked as a reducing and stabilizing agent, enhancing the biodegradability of synthesized nanoparticles. The results of this study can be used to develop a low-cost treatment systems using green synthesis approach for nanoparticles.

***Keywords**:* Moringa oleifera; Nanoparticles; Dye removal; Green synthesis; Photocatalysis

ICAMSF-424

Effect of Biodiesel–Diesel–Ethanol (BDE) Alternative Fuel on Corrosion Behaviour of Magnesium Alloy

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This study investigates the corrosion behaviour of magnesium alloy in Biodiesel-Diesel Ethanol (BDE) fuel blends with varying compositions: B30D60E10, B30D40E30, B7D93, and D100. A static immersion test was conducted at room temperature and 60°C over a period of 504 hours to assess the corrosion rate and fuel degradation. The corrosion rate was determined using a weight loss analysis method, while Fourier Transform Infrared Spectroscopy (FTIR) was used to study oxidation by-products. Results showed that corrosion rate increased with temperature, biodiesel content, and ethanol content, with

ethanol being the primary contributor due to its oxygen and water content. The presence of chloride ions further aggravated corrosion, leading to localized pitting and cracks. Surface analysis indicated the formation of irregular magnesium oxide layers, with darker oxide films at higher temperatures due to accelerated oxidation. Higher ethanol content promoted the conversion of carboxylic acids into ethyl esters, reducing their direct impact on corrosion. However, electrochemical reactions between magnesium and water facilitated increased dissolution. The study concluded that biodiesel and ethanol in BDE fuel blends significantly influence the corrosion behaviour of magnesium, with ethanol playing a dominant role. The findings highlight the need for improved material selection and protective measures when using magnesium alloys in BDE fuel environments.
Keywords: Magnesium corrosion, Biodiesel-Diesel-Ethanol (BDE), Weight loss analysis, FTIR analysis, Electrochemical reaction

ICAMSF-427

Experimental and numerical investigation on directional rigidity of face modified lattice structures

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Lattice structures possess unique properties, including high strength-to-density ratios, high porosity, exceptional energy absorption, lightweight design, and high specific stiffness and strength. These characteristics make them ideal for applications in industries such as automotive, aerospace, sports, and medical devices. This study investigates the directional rigidity of four different face-modified lattice structures through experimental testing and numerical simulations. Specimens were fabricated using the fused deposition modeling (FDM) additive manufacturing method, ensuring precise control over geometry and material distribution. The findings provide valuable insights into the mechanical behavior and potential applications of these lattice designs. The result shows the compressive strength of Vertical opposite triangles face cubic (VOTFC) is higher than other structures. The compressive strength of vertical opposite triangles face cubic (VOTFC) (7.63MPa) is ~57.97 % is higher than cubic structure (CS) (4.83MPa), ~136.22 % higher than the triangle face cubic (TFC) (3.23 MPa), ~ 11.22 % higher than vertical strut face centered cubic (VSFCC) (6.86MPa). The energy absorption capacity of vertical strut face centered cubic (VSFCC) (1.94 MJ/m^3) is 2325 % higher than cubic structure (CS) (0.08 MJ/m3) , ~3133.33 % higher than triangle face cubic (TFC) (0.06 MJ/m3), ~340.91 % higher than vertical opposite triangles face cubic (VOTFC) (0.44 MJ/m3). The specific energy of vertical strut face centered cubic (VSFCC) is also higher than other i.e 149.2 MJ/Kg. The digital image correlation (DIC) method is applied to evaluate the deformation behavior of structures.
Keywords: Lattice structures, compression, Additive manufacturing, Finite element analysis, energy absorption

ICAMSF-429

Treatment of Dyes-laden Wastewater using Ag-based nanoparticles derived from Moringa oleifera seed extract

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The treatment of dye-laden industrial wastewater is a pressing environmental challenge due to the recalcitrant and toxic nature of synthetic dyes. This study explores an eco-friendly and sustainable approach by utilizing Ag-doped Moringa oleifera seeds (MOS) derived nanoparticles for effective dye degradation and wastewater treatment. As Moringa oleifera is widely recognized for its biodegradability, the derived nanoparticles from it exhibit high surface reactivity, making them suitable adsorbent in wastewater treatment. In this view, a green synthesis approach was employed, wherein Moringa oleifera seed extract acted as a reducing and stabilizing agent for the synthesis of Ag-based nanoparticles. The synthesized Ag-MOS-NPs were characterized using point of zero charge determination (pHzpc), UV-Visible spectroscopy, scanning electron microscopy (SEM), X-ray diffraction (XRD) analysis, and Fourier-transform infrared spectroscopy (FTIR), confirming their nanoscale morphology, functional properties, and adsorptive behaviour. Batch experiments were conducted to assess their removal efficiency for methyl blue and methyl orange dyes under optimized conditions, including pH, contact time, nanoparticle dosage, and initial dye concentration. Furthermore, recyclability of investigated nanoparticles was also assessed to evaluate the techno-economic feasibility of the process. The instrumental characterization results confirmed that silver-based nanoparticles offer high surface area and reactivity, making them ideal for adsorption of dyes in wastewater treatment. Overall, the results of the findings of this study revealed the potential of green-synthesis approach-oriented nanoparticle's application for dye degradation.

Keywords: Moringa oleifera; Nanoparticles; Adsorption; Green Synthesis; Wastewater treatment

ICAMSF-431

Effect of cutting speed and the fraction of reinforcement on the tool wear and machining characteristics of AZ91/B4C metal matrix composites

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In this present work, composites of AZ91 magnesium alloy dispersed with 12 and 24 wt. % of B4C particulates of size ~ 20 µm were produced by squeeze casting. Turning experiments were carried out for the developed composites by using diamond coated WC-Co inserts at three different speeds (30, 60, and 90 m/min) and fixed feed (0.24 mm/rev) and 0.2 mm depth of cut to investigate the machining characteristics, surface roughness of the composites and tool wear rate. The incorporated B4C particles

induced the abrasive action and led to severe tool wear while machining the composites. Results revealed higher tool wear with the increased cutting speeds, at higher fraction of B4C. The surface roughness deteriorated with tool nose wear, and greater Ra values were noticed while machining AZ91-24%B4C composite compared with AZ91-12%B4C composite. The cutting forces and surface roughness were increased drastically with machining time at 60 and 90 m/min speeds.

Keywords: composites, magnesium, tool wear, surface roughness, coated WC-Co.

ICAMSF-434

Ophthalmic Biomaterials: A Novel Approach to Retinal Repair

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Biomaterials are substances that interact with biological systems either as a therapeutic or a diagnostic agent. They can be made with different types of materials and can replace or improve a function or an organ, specifically the eye in the case of ophthalmic biomaterials. The predominant applications of biomaterial are tissue engineering, drug delivery system and wound healing. The development of ophthalmic biomaterials necessitates careful consideration of several key requirements including oxygen permeability, refractive adjustability, tissue protection during surgery, and the capacity to modulate tissue healing and integration. Ophthalmic biomaterials such as contact lens, artificial tears, hydrogels, inlays are now highly sophisticated and their usefulness has increased in recent years. Developments in biomaterials are being made using new manufacturing techniques that allow for the production of personalized tissues through advances in stem cell programming, generation tissue imaging and computer-aided design, one such is amniotic membrane transplant. Amnion, the innermost layer of the placental sac can be harvested as a biomaterial for transplant. It is useful clinically due to its unique structure, biocompatible composition and subsequent biological functions. The role of amniotic transplantation in an ophthalmic setting is to support damaged tissue, protect and shield defects from further degeneration or breakdown from external factors and to promote re-cellularisation. This is possible due to biological properties including lack of immunogenicity, preserves and supports stem cells. Whilst inhibiting neoplastic, inflammatory, angiogenic and fibroblastic cellsand facilitates wound healing. The safety and efficacy of amniotic membrane transplantation has been determined in macular holes. The application of amniotic membrane plug transplanted into the sub-retinal space to treat macular holes that failed to close, has been shown an improvement of the anatomical and functional results. Biomaterials, tissue engineering and regenerative medicine are becoming increasingly important to advances in ophthalmology and optometry. However, more research is needed to improve the treatment of severe, vision threatening diseases.

Keywords: Biomaterials, ophthalmology, macular hole, amnion, therapeutic agent

ICAMSF-436

Mineralogical, Microstructural and Toxicity Characterization of Stabilized Subgrade Soils for Sustainable Pavement Construction

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The development of sustainable pavement infrastructure necessitates the integration of advanced materials that enhance durability, efficiency, and environmental safety. Industrial waste materials, when combined with chemical stabilizers and fibres, offer a sustainable alternative to conventional soil stabilization techniques. This study explores the microstructural and mineralogical transformations in brick kiln dust and pond ash stabilized subgrade soils, utilizing RBI Grade 81 as a chemical stabilizer and polyester fibre as reinforcement. The research employs scanning electron microscopy and X-ray diffraction to investigate structural modifications, cementitious compound formation, and reinforcement effects, while toxicity characteristic leaching procedure analysis is conducted to assess the environmental safety of the stabilized soils. Additionally, the toxicity of brick kiln dust and pond ash is examined to evaluate their suitability as sustainable construction materials. The concentrations of potentially hazardous elements such as lead, arsenic, and zinc in the leachate of brick kiln dust, pond ash and RBI Grade 81 stabilized soils were measured and compared with USEPA limits. The results confirm that all detected concentrations remain within the allowable limits, ensuring that the use of brick kiln dust, pond ash and RBI Grade 81 for soil stabilization is environmentally safe and non-hazardous. By leveraging advanced material characterization techniques, this study examines particle interactions, hydration mechanisms, and mineralogical transformations that contribute to the strength and stability of subgrade soils. The findings highlight the crucial role of advanced materials in shaping a sustainable future, demonstrating how the utilization of industrial waste, chemical stabilizers, and fibres can lead to eco-friendly, high-performance, and long-lasting pavement infrastructure. This research advances the sustainable manufacturing and material processing paradigm, paving the way for cost-effective and environmentally responsible construction practices.

Keywords: Sustainable Pavement Construction, Advanced Materials, Soil Stabilization, SEM Analysis, XRD Analysis, Toxicity Assessment, Industrial Waste Utilization, Environmental Safety

ICAMSF-437

Effect of processing routes and external elements on the phase evaluation and mechanical properties of AlCrFeMnNi HEA: A Review

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AlCrFeMnNi high-entropy alloys (HEAs) have drawn interest due to their outstanding mechanical properties, which can be further enhanced through processing techniques and the addition of external elements such as Al, Cu, Cr, and Mn. The manufacturing processes, including arc melting, mechanical alloying, and laser cladding, play a crucial role in shaping the microstructure, mechanical behavior, and overall performance of these alloys. These methods influence factors like grain size, phase distribution, and strength, making it essential to analyze their effects for adapting HEAs to specific applications. The incorporation of external elements has a significant impact on the mechanical characteristics of AlCrFeMnNi HEAs. Aluminum and manganese contribute to improved strength and cryogenic performance, while copper and chromium enhance hardness, tensile strength, and corrosion resistance. A thorough understanding of these influences is key to designing HEAs with optimized properties for various industrial applications.

Keywords: High-Entropy Alloys, Manufacturing Processes, Corrosion Resistance

ICAMSF-438

A Numerical Investigation of Internal Surface Roughness and Its Influence on Additively Manufactured Inlet Manifold Performance

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This study provides a quantitative analysis of how internal surface roughness affects the functionality of an additively manufactured (AM) inlet manifold. With the increasing use of additive manufacturing techniques in engine component production, knowing how surface roughness affects performance is crucial. The performance of an intake manifold is quantitatively assessed for its different interior surface roughness using Ansys Fluent. An arbitrary surface roughness value (Ra) is translated into an equivalent roughness of sand grain height for analysis and simulation. To address turbulence, a k-Ɛ turbulent model with a standard wall function is proposed. The results of the investigation indicated that air flow velocity close to the intake manifold outlet was affected by surface roughness. When compared to a smooth surface, the maximum velocity at the intake manifold outlet of a 1.25 mm roughness surface is found to be 18% lower.

Keywords: Additive Manufacturing, 3D printing, Inlet manifold, CFD Simulations, Surface roughness

ICAMSF-439

Review on the Impact of Processing Routes and External Factors on Phase Formation and Tribological Properties of CoCrFeMnNi HEAs

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High-entropy alloys (HEAs) are a unique class of materials containing five or more than five principal elements in equiatomic or near-equiatomic proportions, exhibiting exceptional mechanical and tribological properties. This review first examines how different processing techniques influence the phase formation, mechanical and tribological properties of CoCrFeMnNi HEAs. The choice of processing method significantly impacts the microstructure, mechanical behavior, and tribological properties of these alloys. Various fabrication techniques, including conventional casting, melt-spinning, mechanical alloying, selective laser melting (SLM), and laser powder bed fusion (LPBF), result in distinct grain structures, strength levels, and durability. Understanding these variations is essential for tailoring HEAs to specific applications. Next, the review explores the role of additional external elements in modifying the phase formation, mechanical and tribological properties of CoCrFeMnNi HEAs. Elements such as aluminum (Al), copper (Cu), chromium (Cr), and manganese (Mn) can enhance mechanical strength and ductility, wear resistance while some additions may lead to brittleness or reduced formability, necessitating careful selection in alloy design.

Keywords: Laser Powder Bed Fusion, High-Entropy Alloys, Tribological Properties

ICAMSF-440

Design and Development of a Customizable 3D Printed Drone

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In this project, we designed, and 3D printed a fully functional drone using CAD software (Fusion 360) and Additive Manufacturing (AM) through the Fused Deposition Modelling (FDM) method. This approach allowed us to create a lightweight, durable, and highly customizable drone that outperforms many commercial models. By leveraging 3D printing, we were able to optimize the drone's aerodynamics, weight distribution, and structural integrity, leading to better flight stability, longer battery life, and increased payload capacity. These improvements make the drone more efficient and versatile for applications such as aerial photography, surveillance, agriculture, and delivery services. One of the key advantages of our 3D printed drone is its cost-effectiveness. Unlike traditional manufacturing methods, which often involve mold making, expensive tooling, and material waste, AM minimizes these costs by

using only the necessary materials and enabling rapid prototyping. This makes our drone an affordable alternative without compromising performance. Additionally, the ability to easily modify designs allows for customization or upgrades to meet specific needs. Sustainability is another major benefit, as the 3D printing process reduces material waste and energy consumption, aligning with eco-friendly practices. Overall, our 3D printed drone represents a significant innovation in the drone industry, combining high performance, affordability, and sustainability for the future.

Keywords: Additive Manufacturing, Fused Deposition Modelling, 3D printing

ICAMSF-442

Tribological properties of refractory high-entropy alloys: A review

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Refractory High-Entropy Alloys (RHEAs) have gained widespread interest due to their remarkable mechanical properties, tribological properties, and corrosion resistance. This review first introduces the fundamental tribological characteristics of RHEAs, followed by an overview of key strategies for enhancing their tribological performance. It systematically examines various aspects, including methods for testing and characterizing tribological properties, as well as the influence of alloy composition on wear behavior. The latest developments in wear resistance and wear reduction, an emerging area of interest, are also highlighted. Furthermore, the effects of surface treatments such as remelting, heat treatment, and ceramization on improving durability are discussed. The review also explores tribological performance under high temperature conditions and offers insights into the future potential of RHEAs in tribological applications. Despite the advancements made, significant challenges persist in optimizing their wear resistance, and recommendations for future research directions are provided.

Keywords: High-Entropy Alloys, Tribological Performance, Alloy Composition

ICMASF-444

Optimization and Prediction of Process Parameters in UA-RECDM of Glass using RSM and Machine Learning Algorithms

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Ultrasonic assisted Rotary Electrochemical Discharge Machining (UA-RECDM) has gained significant attention as an effective technique for machining brittle materials. With increasing interest in enhancing machining performance, researchers are exploring optimization strategies to improve process outcomes.

In this study, a full factorial experimental design was employed to machine borosilicate glass, analysing the influence of key process parameters on machining performance. The response variables considered were hole overcut (HOC) and hole circularity (HC). To optimize the machining process, Response Surface Methodology (RSM) a Multi-Criteria Decision Making (MCDM) technique was applied. The optimization results demonstrated that microholes were successfully drilled with improved HOC and HC under optimal conditions of vibration amplitude, workpiece rotation speed, and tool feed rate. Additionally, four machine learning models were trained on the experimental dataset to predict hole overcut and hole circularity. The models demonstrated a strong predictive accuracy in predicting these machining characteristics. A comparative analysis between the predicted and experimental results was conducted, evaluating the error and similarity between them. Among the four models, one demonstrated the highest accuracy, closely aligning with the experimental outcomes. This study highlights the effectiveness of combining RSM for optimization and machine learning for predictive modelling, offering a robust approach for improving machining performance in UA-RECDM.
Keywords: ECDM; Machine Learning; RSM; Micromachining; Glass

ICAMSF-447

Analysis of lithium-ion diffusion coefficients through different electrochemical techniques of NiMn2O4@MoS2 composite anode material for Lithium-ion batteries

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Lithium-ion batteries (LIBs) have emerged as a prominent energy storage solution across various applications, including portable electronics and electric vehicles. With the ever-growing demand for these batteries, the development of advanced electrode and electrolyte materials is essential to enhance their overall performance. Transition metals, known for their versatile oxidation states, are promising candidates for anode materials. In particular, mixed transition metal oxides (MTMOs) have attracted considerable interest due to their potential to boost battery efficiency. However, these materials often face challenges such as low conductivity and volume expansion during lithium-ion insertion, which restricts their rate performance. 2D Transition metal dichalcogenides (TMDCs) materials can address these issues by promoting a more diffusion path, hence improving lithium insertion. In this study, spinel type NMO has been synthesised using a citric acid-assisted solid-state method while MoS2 has been synthesised using hydrothermal method. X-ray diffraction (XRD) analysis of the synthesized materials confirms the successful formation of the desired phase, exhibiting Fd3m cubic crystal symmetry for NMO and P63/mmc for MoS_2. The crystallite size of NMO@MoS_2 has been determined using the Scherrer equation and W-H plot methods. Electrochemical properties, including Li-ion charge transfer resistance, redox potentials, charge-discharge capacities, cycling stability, and Li-ion diffusion coefficient, have been evaluated in a Li half-cell. These measurements were conducted using Electrochemical Impedance Spectroscopy (EIS), Cyclic Voltammetry (CV), Galvanostatic Charge-Discharge (GCD), and the Galvanostatic Intermittent Titration Technique (GITT), respectively.
Keywords: Anode material, Li-ion batteries, Cyclic Voltammetry, Electrochemical Impedance Spectroscopy, Galvanostatic Intermittent Titration Technique.

ICAMSF-448

Complex Impedance Spectroscopy and Dielectric Analysis of Li4Ti5O12 (LTO) alternative anode material for Li- ion batteries

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The lithium-ion battery represents one of the most significant technological advancements in energy storage, powering everything from portable electronics to electric vehicles. Among the various components of a Li-ion battery, the anode plays a crucial role in determining its overall capacity, efficiency, and cycle life. To meet the increasing demands for high-performance batteries, significant effort is being directed toward developing improved anode materials that address key limitations in energy storage capacity, charging speed, and lifespan. While conventional graphite anodes are widely used, alternative materials like silicon, metal oxides, and lithium titanate ($Li_4Ti_5O_{12}$, LTO) are being explored for their superior characteristics. Among these, LTO has gained attention due to its excellent safety, long cycle stability, and fast charging capability. In this work, LTO was synthesized using the conventional solid-state method, and its structural and electrochemical properties were analyzed. X-ray diffraction (XRD) confirmed the formation of a cubic spinel structure with a space group Fd-3m with crystallite size approximately 228.76A°. Rietveld refinement was conducted on pristine $Li_4Ti_5O_{12}$ (LTO) calcined at 800°C to extract critical structural parameters relevant to its application in energy storage. Crystallite size and micro strain were determined from it, offering insights into the material's defect density and its impact on lithium-ion diffusion. Bond lengths and atomic positions within the unit cell were analyzed, correlating these structural features with ionic conductivity and electrochemical performance. The impedance and permittivity analysis are conducted on the sample using Impedance spectroscopy, revealing that the relaxation process is predominantly controlled by grain boundaries, highlighting their impact on the material's conductivity. The average AC conductivity was determined to be 1.31×10^{-2} S/cm, with an activation energy of 5.25×10^{-3} eV. This study provides deeper insights into the influence of grain boundaries and dielectric behavior on LTO's performance, contributing to a more comprehensive understanding of its functional properties in lithium-ion battery applications. These findings establish a direct relationship between the structural properties of LTO and its suitability for high-performance battery applications. The research enhances the existing knowledge base and supports the potential of LTO as an advanced anode material, paving the way for improvements in energy storage technology.

Keywords: Anode material; LTO; lithium-ion batteries; solid-state synthesis; impedance spectroscopy; grain boundary effects; electrochemical properties; LTO

ICAMSF-449

Impact of Sintering Temperature on Conductivity and Electrochemical Properties of $LiAlSiO_4$ as Solid-State Electrolyte for Li-ion batteries

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All-Solid-State Batteries (ASSBs) are regarded as promising energy storage solutions for rechargeable batteries, addressing safety concerns while keeping high energy density intact. The solid-state electrolytes (SSEs) are the key component of ASSBs with the expectation to drive futuristic advancements in rechargeable battery technology. Conventional Li-ion batteries pose significant safety risks due to the presence of highly flammable liquid electrolytes. In contrast, ceramic-based electrolytes exhibit high flexibility, minimize the risk of liquid electrolyte leakage, excellent ionic conductivity, and superior thermal stability. Among the SSEs, $LiAlSiO_4$ (LASO) ceramics have demonstrated rapid lithium-ion conduction, abundant availability, environmental friendliness and lower cost of raw materials. This highly efficient and economical material presents new opportunities for the commercialization as SSE of ceramic-based solid-state batteries. This study highlights a straightforward and effective approach to fabricate dense ceramics with enhanced Li^+ conductivity through optimization of sintering processes. The influence of sintering temperature and time on grain growth and relative density has been systematically investigated. Thermogravimetric analysis (TGA) has been conducted to assess thermal stability of developed SSE. X-ray diffraction (XRD) is employed to confirm the formation of crystal structure. The average crystallite size of LASO has been estimated by Scherrer's formula and W-H plot based using prominent XRD peaks. Scanning electron microscopy (SEM) characterization is performed for microstructural and detailed surface morphology analysis of the material. Moreover, the electrochemical properties such as ionic/ electronic conductivities, activation energies, and electrochemical voltage window stability are extensively explored for the suitability of developed LASO as solid-state electrolytic material in ASSBs.

Keywords: Solid State Battery, Ceramic Solid Electrolyte, LASO, Ionic Conductivity

ICAMSF-450

Experimental Investigation of Gearbox Faults Using Vibration Analysis and Statistical Methods

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The gearbox faults are the key causes of the breakdown of the rotating machine, therefore dynamic gearbox characteristics are essential. The purpose of this work is to explain the dynamic characteristics of the gearbox as the consequence of the initial pitting condition. Three operating variables such as shaft loading, shaft speed and defect size were selected to observe the parametric effect and the experiment was conducted according to Taguchi L9 orthogonal arrays (OA). A dedicated experimental test rig has been developed for experiments with different speeds and loading conditions to implement and simulate

industrial-based applications. The accelerometer was used to record the vibration signals while simulating faults. The response parameters used to monitor the gearbox conditions comprise time-domain indices notably kurtosis and root mean square (RMS). Investigating the impact of defects on vibrations is made easier by the interplay of defect size, load, and speed. To determine the relationship between the inputs and outputs of a physical system, statistical analytic approaches have been employed. Analysis of variance (ANOVA) has been shown to be a dependable technique for assessing the key elements connected to the gearbox's vibration. It was revealed from the ANOVA table that dynamic characteristics in terms of response performance were significantly influenced by defect size. To mitigate the dynamic features and prolong the life of rotational systems, it is recommended that these optimal input parameter conditions might be applied to gearbox fault diagnosis.
Keywords: Vibration signal, Bevel gearbox, Statistical analysis, Fault diagnosis, Analysis of variance

ICAMSF-451

CFD Analysis of Material Removal Distribution During Two Way Abrasive Flow Finishing of Additively Manufactured 17-4PH steel Components

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Additive manufacturing (AM) has transformed the manufacturing industries by creating complex features directly from computer-aided design files. AM fulfills the key requirements of industry 4.0, and 5.0 through its unparalleled design freedom and sustainable means of production. Due to various inherent existence of surface undulations, staircase and balling effects, the as printed surface roughness of AM parts is very high and necessitates postprocessing to improve the functional properties. Abrasive flow finishing (AFF) is one of the advanced finishing techniques uses a viscoelastic polymer abrasive medium to improve the surface finish. The current work deals with the material removal (MR) CFD model for two way abrasive flow finishing of the additively manufactured 17-4 PH steel workpiece mounted in a cylindrical die with a distance from the walls of 1.5mm. For rheology, the non-Newtonian power law and Preston equation for material removal models were used to create solution data. With the use of numerical analysis of the solution data was interpreted for the formation of the two-way abrasive flow finishing process. For a one-way AFF, MR distribution showed the formation of 4 regions starting from a stagnation zone near the leading region of the workpiece, followed by a non-uniform (transition) low MR zone, a uniform MR zone, and a non-uniform high MR zone at the trailing region. MR distribution in the two-way AFF showed the formation of three different zones such as two low MR stagnation zones on each side of the workpiece during the upward and downward strokes followed by non-uniform zone and uniform MR zone at the center of the workpiece
Keywords: Additive Manufacturing; 3D printing; CFD; Abrasive flow finishing; 17-4PH steel

ICAMSF-452

Taguchi-Based Parametric Optimization of Surface Roughness in Dry Machining of Aluminium Alloy 6061: A Study on Machining Parameters

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The research investigates the optimal approach to implement a CNC vertical machining centre to dry machining of an aluminium alloy 6061 with the objective to achieve optimal surface roughness (Ra). Investigation research on cutting velocity, feed rate, and depth of cut parameters are implemented to optimize the finish on the surface. The research implemented Taguchi L9 orthogonal arrays for experimental design while surface roughness testing happened through a precision surface roughness tester. ANOVA was employed to assess the influence of each parameter on surface finish and to determine their overall contribution to the results. Feed rate showed the highest impact on surface roughness since it was controlled 52.87% of the observed variance followed by cutting velocity 32.18% and depth of cut as 10.43%. Researchers identified the set of parameters which produced minimum surface roughness to provide operational benefits in dry machining practices. Experimental runs used S/N ratio calculation to evaluate surface finish results. This research demonstrates how dry machining acts as a sustainable choice because it eradicates cutting fluid issues but achieves equivalent surface quality standards. The research delivers essential recommendations to industrial operations for maximizing their manufacturing efficiency through cost reductions that support environmentally-friendly manufacturing methods.

Keywords: Surface Roughness (Ra), Dry Machining, Aluminium Alloy 6061, Taguchi Method, ANOVA, (S/N) ratio.

ICAMSF- 453

Influence of Scanning Strategies and Laser Energy Density on the Surface morphology and wear Properties of Selective Laser Melted Inconel 718

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The quality and performance of selective laser melted components are directly influenced by several critical process parameters such as laser power, scanning speed, hatching space and scanning strategies. The selection of optimal process parameters is essential for achieving desirable surface morphology and mechanical properties in fabricated components. This study investigates the effect of three different scanning strategies (0° rotation, 67° rotation, and chessboard scanning strategy) on the surface morphology, microhardness, and wear resistance of Inconel 718 samples. Additionally, the impact of laser energy density levels (low and high) on these properties is evaluated. Among the investigated strategies, the 67° rotation exhibited the lowest surface roughness due to reduced heat accumulation in the melt pool, whereas the chessboard scanning pattern resulted in the highest surface roughness due to

excessive localized heat accumulation. However, the chessboard strategy demonstrated superior microhardness and wear resistance, likely due to absence of Laves phases. In terms of laser energy density, lower energy density samples exhibited lower surface roughness, while higher energy density samples showed increased roughness. Additionally, higher energy density samples displayed improved hardness but reduced wear resistance, attributed to their higher surface roughness. These findings provide valuable insights into optimizing SLM process parameters to enhance the surface and mechanical properties of Inconel 718 components for aerospace and high-performance applications.
Keywords: Wear, Surface Morphology, Scanning strategies, Laser Energy density, Inconel 718, Selective laser melting

ICAMSF-454

Tribological properties of refractory high-entropy alloys: A review

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Refractory High-Entropy Alloys (RHEAs) have gained widespread interest due to their remarkable mechanical properties, tribological properties, and corrosion resistance. This review first introduces the fundamental tribological characteristics of RHEAs, followed by an overview of key strategies for enhancing their tribological performance. It systematically examines various aspects, including methods for testing and characterizing tribological properties, as well as the influence of alloy composition on wear behavior. The latest developments in wear resistance and wear reduction, an emerging area of interest, are also highlighted. Furthermore, the effects of surface treatments such as remelting, heat treatment, and ceramization on improving durability are discussed. The review also explores tribological performance under high temperature conditions and offers insights into the future potential of RHEAs in tribological applications. Despite the advancements made, significant challenges persist in optimizing their wear resistance, and recommendations for future research directions are provided.
Keywards: High-Entropy Alloys, Tribological Performance, Tribological Applications

ICAMSF- 455

Critical Analysis of Turf Material: It's Health & Environmental Perspective

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Artificial turf is increasingly becoming popular as alternative to natural turf for reasons of water conservation and maintenance needs. The research is focused on materialistic analysis between natural &

artificial turf fiber which includes the benefits & drawbacks & their relation to the ecology to determine justification of their use. The research is founded on the triad of literature studies, manufacturer websites and users' perceptions. Natural grasslands not only has the ability to lower temperatures, prevent soil erosion and dust, improve filtration and reduce surface runoff, but it is also an equally beneficial considering its ability to perform psychological functions. The drawbacks arise from high water needs, pesticide and fertilizer requirements, labor and maintenance high costs and (almost) impossible cultivation in tough climate conditions. Artificial turf analyzed on its synthetic nature and material composition has advantages in regard of its always green character, less chemical and maintenance inputs, less water requirements, all weather use, easy installation in difficult zones like terraces, areas with no light, pool surroundings etc. and extended continuous use for multiple sports activities. The disadvantages are in respect to high initial costs, increased sports injuries, limited life span, periodic cleaning requirements, and environmental issues like petroleum use, organic contaminants and heavy metal compositions of infill leading to health and safety concerns. It is concluded that careful choice is to be considered on basis of lawn purpose, availability of maintenance time and costs, user category and harsh growing conditions for best efficiency. There are a lot of challenges and avenues for further research in context to reduction of water usage and organic growing methods for natural turf along with more environment & sports friendly biomaterial compositions for artificial turf.

Keywords: Turf; Material Science; Natural; Artificial; Good Health & Well Being (SDG 3); Sustainable Cities & Communities (SDG 11).

ICAMSF-457

Investigating the role of Silicon in modifying the tribological and other properties of CoCrFeMnNi high entropy alloys

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This study examines the impact of adding silicon on the mechanical properties and microstructure of the CoCrFeMnNi high-entropy alloy system. The alloys were melted using the vacuum arc melting technique, and phase evolution was analyzed with X-ray diffraction (XRD) to gain insights into the alloying process. It is evident from the X-ray diffraction analysis that the addition of silicon encourages lattice distortion and contribute to the observed increase in lattice constant. The Scanning Electron Microscope (SEM) analysis confirms that Silicon addition refined the grain size, leading to a more uniform and finer microstructure. This is due to the solid solution strengthening effect and the potential for silicon to influence the nucleation and growth of grains during solidification. Additionally, microhardness and wear resistance are improved when silicon content is raised from 0 to 0.9. The change of lattice distortion in addition of silicon is principally responsible for strengthening the grain boundaries and increasing the alloy's hardness. This results in improved mechanical properties by reducing deformation and inhibiting dislocation movement. Furthermore, inclusion of silicon increased the corrosion resistance of the alloy exhibited by potentiodynamic polarization studies.

ICAMSF- 458

Effect of heat treatment on the microstructure of Inconel 718 alloy

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Inconel, a superalloy with outstanding mechanical characteristics, exhibits microstructural changes upon heat treatable. This study analyzes the tensile strength, and compressive strength of three heat-treated Inconel 718 plates, comparing these results with those of the 'as received' plate. The two mechanical properties were discussed in the light of microstructural attributes. The microstructural analysis shows that when sand, water, and furnace cooling occur, the needle-shaped δ phase increases. Alloying elements precipitate around the γ boundary. As a result, for heat-treated samples, both the yield and tensile stresses have lowered. The compressive test also revealed a comparable reduction. The heat-treated samples have significantly improved the specimens' elongation up to fracture in the tensile test and up to a specific amount of deflection in the compressive test. The fractured zones of used tensile specimens were closely observed by using FESEM images. The dimple and intergranular fracture were identified by the high-resolution microscopic images.

Keywords: Inconel 718; Heat treatment; optical microscopy; Fractography

ICAMSF- 459

Development of Pistachio shell particulates Filled Epoxy Composites and its Mechanical and Tribological Characterization

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The present work studies the processing and characterization of bio particulate pistachio nutshell/Epoxy composites to achieve an environmentally sustainable material. Samples are prepared for a range of 0-30 wt. % of pistachio shell (PS) particulate. Altogether, 7 samples are prepared i.e. one set of neat epoxy and 6 sets of composites (5 wt. %, 10 wt. %, 15 wt. %, 20 wt. %, 25 wt. %, 30 wt.%). The developed materials are studied for their physical, mechanical and sliding wear properties. The surface morphology of the filler and composites and filler elemental composition are investigated in the work. The density of the epoxy increases with PS particulate content and so does the water uptake rate. The maximum density measured is 1.23 g/cm3 and the water uptake percentage is 3.16 % for maximum filler loading. The tensile and flexural strength is reported for 30 wt. % PS content. The maximum moduli are 2765 MPa and 9.76 MPa for tensile and flexural loading respectively. The compressive strength and hardness show an

interesting increment showing an appreciable improvement of for 30 wt. % filler loading. The sliding wear characteristics were studied by performing the experiment designed as per the L25 orthogonal array suggested by Taguchi's design of the experiment method. From the analysis, it was detected that the PS particulate loading influenced the specific wear rate the most, whereas normal load was the least influential factor. The worn surface morphologies are analyzed to determine the wear mechanisms of the developed material under various situations.

Keywords: Epoxy, Pistachio Shell (PS), Mechanical properties, Taguchi Method, Sliding wear behavior

ICAMSF- 460

Predication and Optimization of Hardness Parameters of SAE 1080 Carbon Steel Strip using Taguchi L9(33) Orthogonal Approach

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This study involves the predication and optimization of two-stage heat-treatment and oil quenching processes parameters of cold rolled carbon steel strip SAE 1080. The experiment runs were designed using the Taguchi method and three process parameters, viz., flame/soaking temperature ranges in zone 1-2-3-4, strip speed, tempering temperature, each with three levels. In this regard, Taguchi L9(33) orthogonal array-based design of experiment protocol were employed to achieve the targeted hardness values of steel strips rolls. Signal-to-noise (S/N) ratio with nominal-is-best was set to optimize the main effect or variation of each control factor towards attaining the hardness values. The S/N ratios results obtained through investigation of hardness analysis revealed the average of each response characteristic of S/N ratios for each level and factor including ranks based on delta statistics compared to the relative magnitude of effects. The average hardness values found in the range of 44.4 ± 0.4 HV to 42.1 ± 0.5 HV. The responses were evaluated using the Taguchi analysis and the analysis of variance (ANOVA). From the Taguchi analysis, the signal-to-noise ratios were obtained. From the ratios, the minimum average surface roughness was obtained as 0.906 µm. These values represented the optimal responses. For the minimum average surface roughness, the optimal parameters were clearance angle of 22.65°, 755 rpm cutting speed and 0.7 mm depth of cut. Consequently, for the maximum material removal rate, the optimal parameters were a clearance angle of 22.65°, a cutting speed of 755 rpm and a depth of cut of 0.5 mm. From the ANOVA, the clearance angle was identified as the most significant factor contributing to surface roughness.

Keywords: Taguchi method; Parameter design; Heat-treatment process; Cold rolling

ICAMSF-461

Enhancing Material Removal Rate in Face Milling of AISI 1040 Steel: A Statistical Approach Using ANOVA

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To achieve mass production at a low cost, reducing manufacturing time is crucial. This study proposes a systematic approach based on Taguchi's methodology to optimize the material removal rate (MRR) during the face milling of rolled steel (AISI 1040). Experiments are carried out on a vertical milling machine (HURCO-VM10) using a 75 mm diameter face milling cutter. The parameters considered include cutting speed, feed rate, depth of cut, and rolling direction. The experimental design follows Taguchi's L9 (34) orthogonal array, and the MRR is calculated. The Signal-to-Noise (S/N) ratio is utilized to identify the optimal levels of the process parameters. Analysis of variance (ANOVA) is conducted to determine the significant factors, optimal settings, and the contribution percentage of each parameter. The ANOVA results indicate that the depth of cut has the greatest influence on MRR, contributing 76.19%, followed by feed rate, cutting speed, and rolling direction with contributions of 11.22%, 7.38%, and 4.17%, respectively.

***Keywords*:** Material removal rate (MRR), Face milling, AISI 1040 steel, Taguchi methodology, Signal-to-Noise (S/N) ratio, Analysis of variance (ANOVA)

ICAMSF-462

Optimization of Material Removal Rate (MRR) in Dry Turning of EN8 Steel Using CNC Lathe: A Taguchi-Based Approach

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This research focuses on improving the machinability of EN8 steel by optimizing the material removal rate (MRR) during dry turning on a computer numerical control (CNC) lathe. The study investigates the effects of three critical input variables - cutting speed, feed rate and depth of cut on machinability. This is approached as a multi-objective optimization problem aimed at maximizing the material removal rate. An L27 Taguchi orthogonal array is employed for the experimental design and responses are measured after completing the machining trials. To analyze the data, the study uses Analysis of Variance (ANOVA) through Minitab software to evaluate how each input parameter influences the outcome. The results highlight that feed rate plays the most significant role in enhancing the material removal rate, followed by depth of cut and spindle speed. Based on the experimental findings, the optimal set of parameters for achieving the highest material removal rate is identified as a spindle speed of 1100 RPM, a feed rate of

0.42 mm/rev, and a depth of cut of 1.2 mm. This combination provides the most efficient material removal while improving the machinability of EN8 steel in dry turning operations.

***Keywords*:** EN8 Steel, Material Removal Rate (MRR), Dry Turning, Taguchi Method, Optimization, Analysis of Variance (ANOVA).

ICAMSF-463

Effect of N-Octane, Water and Ethylene Glycol Using as a Fluid in Rectangular MicroChannel Heat Sink

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The technology in electronic devices have been revolutionized and getting moreinnovative and sophisticated day by day. During recent trends in electronic devices, micro channel plays a significant role as a heat dissipation in electronic components. The reasonbehind that due to its size compactness and heat transfer capability, adaptability to dissipateany kind of heat. liquid cooling is more acceptable method used in micro-channel heat sinkrather than air cooling technique. In this research work more focus is given up on the heatdissipation by using micro-channel heat sink from the liquid devices.The liquid devices suchas N-Octane,Water and Ethylene glycol employed in micro-channel heat sink.The liquiddevices having a huge impact on the performance of heat transfer in electronic devices. So inthis present work a numerically investigated heat transfer through rectangular micro channelis being used and three different types of fluids are being used i.e. Ethylene glycol, N octane,and Water.And it has been found that water having a 52% more heat transfercoefficient than n-octane and 35 % more heat transfer coefficient than ethylene glycol.Thereason behind that water has high thermal conductivity; high specific heat and appreciableheat transfer properties whereas Ethylene glycol, having lower thermal conductivity andhigher viscosity lesser efficient than water and N-octane exhibits low thermal conductivityand specific heat capacity, leading to poor cooling performance in micro-channel heat sink. Keywords: Microchannel Heat Sink (MCHS), Aspect Ratio (A-R), Ethylene glycol, N octane, liquid cooling.

Keywards: N-Octane, Microchannel Heat Sink, Ethylene glycol

ICAMSF-465

Surface Modification of Nano-Material for Enhanced Microplastic Removal

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Water quality is a critical factor in maintaining human health, supporting economic growth, and preserving ecological balance. However, the rapid expansion of human populations and industrial activities in the 21st century has led to severe environmental challenges, particularly concerning wastewater management. More than 80% of wastewater from urban, industrial, and agricultural sources is discharged directly into rivers and seas, exacerbating water pollution. Among the most pressing concerns is plastic pollution, with many plastic products designed for durability but persisting in the environment

for up to a century. A significant consequence of this persistence is the formation of microplastics (MPs) and nanoplastics (NPs), which originate from the breakdown of larger plastic items. These microscopic pollutants, including polystyrene (PS), polyethylene (PE), and polypropylene (PP), not only threaten aquatic ecosystems but also pose serious risks to human health through water contamination. Addressing this issue requires effective wastewater treatment strategies, with recent advancements in nanotechnology offering promising solutions for the selective identification and removal of MPs and NPs. These emerging techniques enhance removal efficiency and enable targeted extraction of specific microplastic types, representing a significant step toward ensuring clean and safe water for communities. This paper explores the growing challenge of microplastic contamination, the limitations of conventional wastewater treatment, and the potential of novel nanomaterial-based approaches to mitigate the environmental impact of MPs and NPs.

Keyword: Microplastics, Nanoplastics, Water Pollution, Wastewater Treatment, Nanotechnology

ICAMSF-467

Sustainability Assessment of Turning Operation During Machining of AZ91D Alloy During Dry, MQL, RHVT Cooling Environment

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Magnesium is regarded as a lighter metal and is advantageous for industry because of its lowest density. Applications for magnesium include industrial, automotive, biomedical, and aerospace. Because of the current emphasis on lowering emissions, increasing efficiency without endangering the environment, and enhancing machine economy, magnesium shows promise. Because magnesium has a low melting point, it can burst when machined at high speeds. This makes it extremely difficult for the industry to machine the hard-to-cut AZ91D material. In this paper, try to evaluate the effect of speed, feed rate, and depth of cut on turning with different cutting environments. Dry, minimum quantity lubrication (MQL) and Ranque Hilsch vortex tube (RHVT) environments selected for machining. For certain conditions, it finds that surface roughness decreases with cutting velocity Vc and feed rate, but increases with feed rate. AZ91D can be cut at a moderate speed when it's dry. During dry conditions, higher temperatures were recorded, which could have an impact on tool life. It observed that RHVT can replace MQL in certain conditions. MQL and RHVT reduce temperature up to 25% and 40% than dry. RHVT shows good cooling effect during machining and can be considered as a future lubrication purpose.

Keywords: Minimum Quantity lubrication (MQL), Ranque-Hilsch vortex tube (RHVT), Dry machining, AZ91D Alloy, Cutting environment, Cooling effect

ICAMSF-469

Effect of Particle Size on Physical and Mechanical Properties of Micro Sized Pistachio Shell/Epoxy Composites

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The main aim of this paper is to explore the potential utilization of bio waste produced during the waste processing of Pistachio Shell (PS) as a filler material in the polymer matrix material to develop a new class of environmentally friendly composite material. In the present work, composites are fabricated with an epoxy matrix and their physical and mechanical properties are analyzed. The hand lay-up method was implemented to prepare the epoxy/PS particulate composite and different sets were developed with PS particulate loading of 5, 10, 15, 20, 25
and 30 wt. %. The properties evaluated in the work are a function of the loading and size of the PS particulate. For that, three different sizes of PS particulate (50, 75 and 100 microns) and accordingly, three sets of composites were fabricated. The density, void content, and affinity towards moisture of the samples increased with PS particulate content. The highest tensile and flexural strength is registered at 30 wt. % of PS particulate. The percentage elongation decreases with filler loading, whereas the modulus increases. The hardness and compressive strength show an increasing trend. The study also found that composites with smaller particles exhibit superior properties.
***Keywords*:** Epoxy, Pistachio Shell (PS), Particulate Size, Mechanical properties and Physical properties

ICAMSF-473

Performance Improvement Approaches for Crystalline Silicon Solar Photo-voltaic Module using Augmented Heat Dissipation Approaches- A Review

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Renewable energy is becoming instrumental in ensuring the sustainability. Electricity from solar photo-voltaic systems has been significantly contributing to fulfil energy demands of the world in an eco-friendly manner. However, solar photo-voltaic systems are facing the issue of lower conversion efficiency. Researchers have been working towards improving the efficiency of solar photo-voltaic systems. This paper comprehensively reviews the factors affecting the efficiency of crystalline silicon

solar photo-voltaic systems and the various approaches to improve the efficiency of these systems. This significantly affects the conversion efficiency of solar photo-voltaic system. Apart from decrease in efficiency, increased temperature of solar photo-voltaic system is also responsible for detectable failures like discoloration, corrosion, delamination, cracks etc. Some of the approached are radiates cooling, the use of fins, high thermal conducting back sheet, use of phase change materials, etc. The findings and recommendations presented in this paper can guide researchers, engineers, and policymakers in developing efficient and reliable solar photo-voltaic systems, contributing to the wider adoption of renewable energy technologies.

Keywords: Absorption, Solar PV module, Efficiency improvement, Photovoltaic cell, phase transformation, Hybrid Photovoltaic thermodynamics.

ICAMSF-474

FEA of Welded Joint of Chrome Molly Alloy and Stainless Steel Formed by Laser Engineered Net Shaping at Higher Temperature

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Due to challenges posed by conventional welding method in formation of dissimilar metal weld, the use of transition joints between dissimilar metals are also becoming increasingly importance these days. The gradual change in composition in the transition zone reduces the stresses at the weld interface. The novel technique called as Laser Engineered Net Shaping (LENS) can be effectively used in formation of transition joint of stainless steel and other steel alloys. The present paper conducted finite element analysis of transition graded joint of Chrome molly alloy (SA335 P11) and Stainless steel (SA312 TP304) to determine the residual stress in the joint at elevated temperature. It also investigated the effect of number of layers of deposition and width of transition zone on stresses distribution in the dissimilar metal graded joint. The joint exhibited increase in stresses at smaller layer thickness and significant decrease in stresses in larger width of transition zone at high temperature.

Keywords: Finite Element Analysis (FEA), Laser Engineered Net Shaping (LENS), Chrome-Molly Alloy, Welded Joint Integrity, Residual Stress Analysis, High-Temperature Welding

ICAMSF-475

Battery-Super Hybrid Capacitors as Potential Energy Storage Systems for Future E-Mobility: A viable Alternative to lithium-Ion Batteries

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Battery-super hybrid capacitors (BSHCs) are gaining attention as a viable alternative to lithium-ion batteries for e-mobility due to their superior power density and improved energy storage capabilities. Using some key studies—Montenegro-Oviedo et al. (2024), Jayaraman Sundaramurthy et al. (2017), and

He. Shenggong et al. (2020)—this work compares the charge discharge efficiency, power density, and lifecycle stability of BSHCs. Of these, Jayaraman Sundaramurthy et al. present a better set of performance metrics based on optimized electrode materials and electrolyte formulations. Similarly, He. et al. (2020) explored advanced energy storage solutions by using expanded graphite as a cathode for anion intercalation supercapacitors and as an anode for cation intercalation batteries, achieving impressive power densities (403–7130 W/kg) and energy densities (356.5–462.9 Wh/kg) through an amalgamation of electrochemical double-layer capacitance and faradaic pseudo capacitance. Another important aspect to highlight includes hybrid supercapacitors; Muzaffar et al. (2019) studied that based on asymmetric electrode configurations, more specific capacitance, and better cycling stability can be achieved than is possible with typical "EDLCs (Electric Double Layer Capacitors) and pseudo capacitors". Novel nanomaterial incorporation and optimization in electrode architectures result in promising ways of high-performance energy storage systems in electric vehicles.

***Keywords*:** Super hybrid capacitors, lithium-ion batteries, Energy and Power density, Potential energy storage, EV Technology.

ICAMSF-476

Use of Bio-materials for Sustainable Pavement Construction: A bibliometric analysis for mapping research landscape

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The integration of bio-materials in pavement construction is revolutionizing sustainable infrastructure by enhancing durability, reducing carbon footprints, and optimizing resource efficiency. This study conducts a bibliometric analysis to explore the research landscape, emerging trends, and future directions of bio-material applications in sustainable pavement construction. By analyzing scholarly publications from the Scopus database, key research themes such as bio-based binders, recycled aggregates, nanomaterials, and green additives are identified. The findings underscore the increasing role of bio-material technologies, including bio-asphalt, biopolymers, and microbial-induced calcite precipitation, in addressing environmental and economic challenges. The study also highlights gaps in the literature, emphasizing the need for interdisciplinary collaboration and large-scale implementation of bio material solutions. Future research should focus on improving material performance, ensuring cost-effectiveness, and addressing regulatory challenges. This bibliometric analysis provides valuable insights for researchers, policymakers, and industry practitioners striving to advance sustainable pavement construction through innovative bio-material applications.

Keywords: Bio-materials; sustainable pavement; sustainable construction; bibliometric analysis; eco-friendly road materials.

ICAMSF-477

Investigation of Dielectric Relaxation, Charge Transport and Electrochemical Performance to Explore $Na_3Zr_2Si_2PO_{12}$ as a potential Solid-State Electrolyte

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Solid-state electrolytes are emerging as a promising alternative to liquid electrolytes in sodium-ion batteries due to their enhanced safety, stability, wide potential window and electrochemical performance. Herein, the effect of sintering temperature on the dielectric relaxation, conduction mechanism, and electrochemical performance of Na3Zr2Si2PO12 (NZSP) solid electrolyte for all-solidstate sodium-ion batteries has been systematically investigated. Synthesis of NZSP has been attempted via solid-state reaction route keeping the sintering temperatures range from 1100°C to 1250°C. X-ray diffraction (XRD) patterns confirmed the phase purity, with the monoclinic structure being dominant at 1050°C. Scanning electron microscopy (SEM) reveals the microstructural changes in terms of densification and grain growth with increasing sintering temperature. AC impedance spectroscopy has been performed using LCR meter, it demonstrated a decrease in total resistance with sintering up to 1200°C, beyond which resistance increased due to excessive grain growth and reduced grain boundary density. Sample NZSP at 1200 °C (NZSP1200) sintering also showed the highest ionic conductivity of 1.55×10^{-3} S/cm at room temperature. Dielectric analysis indicates the Maxwell-Wagner polarization at low frequencies, with increased permittivity at higher temperatures due to enhanced charge carrier alignment. The dielectric loss spectra showed thermally activated relaxation behaviour, with an activation energy of 0.37 eV. The study provides insights into optimizing sintering conditions for improved NZSP solid electrolytes, facilitating advancements in sodium-ion battery technology.

Keywords: Sodium Solid-State Electrolyte, NZSP, Ionic conductivity, Impedance Spectroscopy, Dielectric Relaxation, Solid-State Battery

ICAMSF-478

Investigation of Minimum Quantity Lubrication and Cutting Parameters on Surface Roughness in Milling of EN8 Steel: A Taguchi Approach

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This experimental study was conducted to investigate the effect of Minimum Quantity Lubrication (MQL) and various cutting parameters i.e. cutting speed, depth of cut, and feed rate, with a focus on understanding their impact on surface roughness during the milling of EN8 steel. The experiments were carried out using an end milling process on a Universal Milling machine. To design the experiments systematically, Taguchi's L9 orthogonal array was applied, which included different cutting parameters and lubrication conditions. The selected cutting parameters for the study were cutting tool speeds of 90, 172, and 367 rpm, depth of cut values of 0.4, 0.6, and 0.8 mm, and feed rates of 7.2, 13.76, and 29.36

mm/min. The lubrication conditions investigated in the study included Dry, Flooded, and Minimum Quantity Lubrication (MQL). Taguchi's "smaller the better" approach was used for determining the optimal conditions that would provide the lower surface roughness. The study revealed that the use of minimum quantity lubrication is as effective as using conventional cutting fluid, with an added advantage of the former being very environment friendly.

Keywords: Minimum Quantity Lubrication (MQL), Surface Roughness, EN8 steel, Taguchi's L9 Orthogonal Array, Lubrication Conditions.

ICAMSF-480

Development of Filament Extruder Machine for Quality Improvement of 3D Printing Material

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This paper aims to investigate the mechanical properties such as tensile and compression test by making filament extruder. Filament extruder is essential for the production of single or composite materials using raw materials. Advancement in filament extruder technology directly enhances material characteristics. Acrylonitrile Butadiene Styrene (ABS) filament is generated with this extruder and then compared with commercially available ABS filament. Optical microscope analysis showed that the extruded filament has a lower concentration of impurities compared to the commercially available filament. The tensile and compression strengths of the extruded ABS filament demonstrated exceptional performance. The outcomes indicate that the created filament extruder improves the quality of ABS material. Further research may be directed towards the growth of filaments using other materials and composites.

Keywords: Filament Extruder, Acrylonitrile Butadiene Styrene, Optical microscope, Performance, Composites

ICAMSF-481

4D Printing: A Futuristic Application of Smart Materials in Material Extrusion Process

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Recent research has focused on shape-memory smart materials and structures because of their unique shape-remembering, dimensionally flexible, structurally programmable, and multi material compatible characteristics. Shape memory polymers (SMPs) are still difficult to print in four dimensions using the material extrusion method, particularly because SMPs with lower glass transition temperatures are more likely to experience high thermal strains. In the present study, challenges and applications of various selected stimulus that is thermo-responsive, magneto-responsive, hydrogels, electro-responsive, and photo-responsive smart materials etc. has been explored. 4D printing application includes medical application, industrial, soft robotics, and agriculture etc. also has been explored. Scope and feasibility of

different stimulus materials with respect to fused deposition modeling (FDM) process in 4D Printing is reviewed in present study. In future other compatible smart material with additive manufacturing can be developed and also cost and speed of production can be optimized.

Keywords: 4D Printing; Smart materials; Properties; FDM; Challenges and Applications.

ICAMSF-482

Optimization and Predictive Modeling of Robotic CMT Welding for AISI 304 Stainless Steel Using Machine Learning

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This research paper presents a comprehensive analysis of key mechanical properties-Tensile strength, Impact Charpy Test, Microhardness Vicker Test (Weld Part, Heat Affected Zone, Base Part)-of Stainless steel304 subjected to Cold metal transfer (CMT) welding. The study systematically investigates how various input parameters like current, welding speed, dynamic correction factor, contact tip to weld distance in the CMT welding process influence these output characteristics. By employing Analysis of variance, Response optimizer,Machine learning algorithms such as Support Vector Machine (SVM), Random Forest, and Decision Tree, we predict the welding outcomes with high accuracy. Experimental data is collected and processed to train these models, which are then validated to ensure robustness. The findings demonstrate the effectiveness of these models in predicting the mechanical properties, thereby optimizing the CMT welding process for improved performance. This approach not only enhances the understanding of the welding parameters but also offers a predictive framework that can be utilized in industrial applications to achieve desired welding quality with greater precision.

Keywords: CMT, Support vector machine, Random Forest, Decision tree, Optimization, Microhardness

ICAMSF-483

Investigation of Nafion 117 based E- Nose and E-tongue in Food Industry.

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In this era of rapid industrialization, the lot of challenges of the food industry is analyzed by the role of biosensors technology to mimics the human senses is gaining the popularity rapidly. The two types of sensors typically popular are gas and the chemical sensors. The high cost of gas sensors and their complexity of operation lead to the development of alternative materials for the same. The ionic polymer metal composites due to their unique sensing and biocompatibility properties are evolving as the important alternates for the sensor materials. Nafion 117 is a kind of IPMC and the cost of Nafion 117

based E –sensors is relatively cheaper as compared to the other materials. The critical property of Nafion 117 for overall sensory performance coated with the neutral material make it suitable to be used a chemical sensor material for investigation of food quality. These Nafion -117 based chemical sensors uses the pattern-based recognition system for the same. With this pattern-based quality system the sensors are used to match the pre stored patterns with the desired responses. The high-resolution cameras and monitors were used to display the output responses. The low cost and low actuation energy if nafion 117 makes them suitable for the sensor technology. In addition, with these properties nafion 117 also exhibit all kind of strain mechanism on application of applied voltage. This paper investigated the role of Nafion 117 based chemical sensors in determination of food quality by the use of E-nose and E- tongue in the food industry

Keywords: Nafion 117, Food Industry, Complexity of Operation

ICAMSF-484

Performance analysis of manufacturing systems: evaluating automation strategies using simulation and mcdm techniques

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Manufacturing systems are meant to deal with the modern problems everyday keeping in mind the performance of the system does not deteriorates. The manufacturing systems should be such that they can accommodate and adapt the changing market trends. One of the most significant aims of system designers is to analyze the performance of system during the varying conditions. The present study is all about system performance when different automation strategies are applied to the systems. This work has been divided into two parts; one is developing the simulation models based on the concerned automation strategy and second is analyzing the results generated from these simulation models. There are presently two automation strategy models based on Increased (Routing) Flexibility and Integration of Operations. In the former case, various sequencing and dispatching rules along with different levels of routing flexibility are employed and in the latter case, different levels of part integration is done along with the various sequencing rules. With all these efforts significant improvement in performance namely Makespan, Utilization and WIP is observed at designated levels. Since selecting the best automation strategy would be a tough task when having different performance criterion, so finally in order to rank the automation strategy based on the overall performance, two Multi Criteria Decision Making (MCDM) methods are applied. These are, Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) and Weighted Aggregates Sum Product Assessment (WASPAS).

Keywords: Manufacturing systems, Performance Analysis, Multi Criteria Decision Making (MCDM), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), Weighted Aggregates Sum Product Assessment (WASPAS).

ICAMSF-485

Enhancement Of Thermal Management in Combustion Chambers by Using Bio-Inspired Material

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This paper looks at using honeycomb structures to improve thermal management in rocket engine combustion chambers. A systematic design process was followed with SolidWorks for design and ANSYS for analysis to investigate the structural integrity, thermal performance and suitability of honeycomb structures for rocket propulsion. The results show that honeycomb structures have excellent structural integrity, efficient heat dissipation and resistance to resonance issues making them great for rocket combustion chambers. The findings show the potential of biomimetic design in aerospace engineering and the efficiency and effectiveness of mimicking natural structures like honeycombs. The proposed material will be designed and synthesized using a combination of experimental and computational methods, with a focus on achieving optimal thermal conductivity (k = 5-10 W/mK), specific heat capacity (Cp = 1000-2000 J/kgK), and thermal stability (up to 1500°C). The material will be integrated into a combustion chamber and evaluated under various operating conditions, including temperature, pressure, and flow rate. Also, future work is identified including optimization of honeycomb structure parameters, integration of advanced materials and manufacturing techniques and multidisciplinary study of propulsion efficiency and environmental impact. Overall, this research contributes to the field of rocket propulsion and shows the promise of bio-inspired solutions in solving complex engineering problems in space exploration and transportation.

***Keywords*:** Honeycomb structure, Thermal management, CFD, Combustion Chamber, Bio material

ICAMSF-486

Performance analysis of manufacturing systems: evaluating automation strategies using simulation and mcdm techniques

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Manufacturing systems are meant to deal with the modern problems everyday keeping in mind the performance of the system does not deteriorates. The manufacturing systems should be such that they can accommodate and adapt the changing market trends. One of the most significant aims of system designers is to analyze the performance of system during the varying conditions. The present study is all

about system performance when different automation strategies are applied to the systems. This work has been divided into two parts; one is developing the simulation models based on the concerned automation strategy and second is analyzing the results generated from these simulation models. There are presently two automation strategy models based on Increased (Routing) Flexibility and Integration of Operations. In the former case, various sequencing and dispatching rules along with different levels of routing flexibility are employed and in the latter case, different levels of part integration is done along with the various sequencing rules. With all these efforts significant improvement in performance namely Makespan, Utilization and WIP is observed at designated levels. Since selecting the best automation strategy would be a tough task when having different performance criterion, so finally in order to rank the automation strategy based on the overall performance, two Multi Criteria Decision Making (MCDM) methods are applied. These are, Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) and Weighted Aggregates Sum Product Assessment (WASPAS).

Keywords: Manufacturing systems, Performance Analysis, Multi Criteria Decision Making (MCDM), Weighted Aggregates Sum Product Assessment (WASPAS).

ICAMSF-489

Copper Target Material Surface Stress Analysis due to Impact of Mild Steel Particles in Slurry Erosion Wear

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Stress developed on target material surface due to impacting particles plays crucial role in slurry erosion wear. However, this stress factor depends on many other parameters like impacting particle size, shape, density, velocity etc. Therefore, to predict erosion wear on the basis of purely stress concentration other parameters effect should be nullifying. In view of this in present investigation spherical shape of mild steel particles are used to impact on copper material target surface with constant kinetic energy. Two different techniques have been used to determine stress concentration on target surface namely; Hertz contact theory and numerical technique (ANSYS) which further validated experimentally. The diameter of indentation craters on copper specimen due to impact of spherical shape mild steel particles slightly increases with increasing the particle size, thus, the stress concentration decreases for constant kinetic energy. The numbers of indentation craters on copper specimen increases with increasing particle size of spherical shape. It reveals that the collision efficiency increases with the particle size which is responsible to remove more material from target surface. Finally, it is observed that that the effect of stress concentration on target material due to different size erodent impacting with constant kinetic energy plays crucial role in slurry erosion wear assuming 100% collision efficiency. The results obtained by using Hertz's contact theory and ANSYS explicit dynamics software are in line with the experimental results with maximum 6.29 % error.

Keywords: stress concentration; erodent; spherical; copper; mild steel; hertz contact theory.

ICAMSF-491

Renewable Energy Transitions: Enhancing Environmental and Energy Security Abhishek Kulkarni1, Surendra Kumar Yadav2, Hemant Kumar3, Ashu Yadav4

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The degradation of the environmental factors and a continuous change in the climatic conditions are a few of the most alarming elements of the fact that it is a high time that we switch from conventional energy sources to the renewable energy sources. Over the past decade there has been an overall increase in the use of the renewable energy due to technological innovations. This leads to the environmental sustainability by reduction in CO2 emissions. To maintain this sustainability, a lot of a lot of countries have started various initiatives which promotes the development of the renewable energy. As we are aware that conventional energy sources rely on the fossil fuels that lead to the increased CO2 and GHGs in the environments causing worsening of the environmental factors, the continuous innovations in the field of renewable energy have reduced the risk of energy security. Currently, a lot of effort is also being put over the fact that if one or more renewable energies are combined together, a more efficient and economical framework can be made and can lead to a sustainable social, economic as well as environmental growth. Further research in this area can lead to a better tomorrow by identifying the gaps such as localization of the Renewable Energy Technology deployment, Hybrid Renewable Energy Technology and its socio-economic impacts.

Keywords: Renewable Energy, Environmental Sustainability, CO2 Emissions, Technological Innovations, Energy Security,

ICAMSF-493

Sustainable Energy Solutions for Urban Futures: Pathways to Low -Carbon Cities

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Urban areas use an extensive amount of energy necessitating sustainable energy solutions that will help reduce adverse effects on the environment and maintain energy security. Due to the increase in urban population, the reliance on fossil fuels has also increased. This has resulted in the emission of greenhouse gases and climate change. To counter such an issue, it becomes essential to find sustainable energy solutions. Renewable energy technologies, smart grid innovation, and energy-efficient systems are some of the effective solutions to target the decarbonization of urban environments. This research examines different renewable energy sources like wind, solar, biomass and geothermal energy to highlight their effectiveness in highly populated areas. It also emphasises that adopting energy efficiency measures such as smart lighting, green buildings, and strategic urban planning helps reduce energy demands. In addition, it analyses how the integration of smart grids, battery storage solutions, and demand-side management

systems can contribute towards enhancing power distribution and reducing energy consumption. However, there are many challenges in implementing sustainable energy solutions despite having potential benefits. Some of the challenges include regulatory barriers, high initial costs, and technological limitations that affect widespread adoption. Moreover, encouraging people to shift towards a sustainable energy system involves public awareness and involvement which demands educational programs and community engagement initiatives. However, a shift to sustainable energy in cities can be sped up with better financial support, policy framework and innovation. Examples from cities such as Copenhagen, Freiburg, Singapore, and San Diego that have successfully implemented sustainable energy practices reveal how public institutions, commercial entities and local populations work together to reach energy efficiency goals along with carbon neutrality targets. The city of Copenhagen has been successful in lowering its carbon emissions through the use of offshore wind energy and district heating systems. Freiburg is famously known as the "solar city" because of its adoption of passive house standards and the implementation of extensive solar power facilities throughout the town. Moreover, the cities of Singapore and San Diego have implemented smart grid technologies and green building certifications, and microgrids and electric vehicle integration, respectively. To conclude, the implementation of sustainable energy solutions serves as a fundamental method to reduce the adverse impact on the environment and maintain long-term urban stability. Cities can transition to better energy systems by adopting a wholesome approach that integrates technological innovation, supportive policies and the use of renewable energy. An attempt should be made by future research to enhance energy storage technologies and grid resilience together with promoting worldwide collaboration in sustainable urban energy programs. For the effective transition towards sustainable energy in urban areas, a collaborative effort between policymakers, citizens and businesses is crucial.

Keywords: Sustainable energy, urban areas, renewable energy, smart grids, energy efficiency, urban sustainability, decarbonization, net-zero cities.

ICAMSF-495

Impact of Sintering Temperature on Conductivity and Electrochemical Properties of LiAlSiO4 as Solid-State Electrolyte for Li-ion batteries

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All-Solid-State Batteries (ASSBs) are regarded as promising energy storage solutions for rechargeable batteries, addressing safety concerns while keeping high energy density intact. The solid-state electrolytes (SSEs) are the key component of ASSBs with the expectation to drive futuristic advancements in rechargeable battery technology. Conventional Li-ion batteries pose significant safety risks due to the presence of highly flammable liquid electrolytes. In contrast, ceramic-based electrolytes exhibit high flexibility, minimize the risk of liquid electrolyte leakage, excellent ionic conductivity, and superior thermal stability. Among the SSEs, $LiAlSiO_4$ (LASO) ceramics have demonstrated rapid lithium-ion conduction, abundant availability, environmental friendliness and lower cost of raw materials. This highly efficient and economical material presents new opportunities for the commercialization as SSE of ceramic-based solid-state batteries. This study highlights a straightforward and effective approach to fabricate dense ceramics with enhanced Li^+ conductivity through optimization of sintering processes. The influence of sintering temperature and time on grain growth and relative density has been systematically

investigated. Thermogravimetric analysis (TGA) has been conducted to assess thermal stability of developed SSE. X-ray diffraction (XRD) is employed to confirm the formation of crystal structure. The average crystallite size of LASO has been estimated by Scherrer's formula and W-H plot based using prominent XRD peaks. Scanning electron microscopy (SEM) characterization is performed for microstructural and detailed surface morphology analysis of the material. Moreover, the electrochemical properties such as ionic/ electronic conductivities, activation energies, and electrochemical voltage window stability are extensively explored for the suitability of developed LASO as solid-state electrolytic material in ASSBs.

Keywords: solid state battery, Ceramic solid electrolyte, LASO, ionic conductivity

ICAMSF-497

Analysis of Erosion Mechanisms and Mitigation Strategies in Hydro-Turbines

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Hydropower, a cornerstone of global electricity generation, faces significant operational challenges stemming from silt-induced erosion. This phenomenon is particularly acute in regions experiencing high sediment loads, such as Northern India, where monsoon seasons dramatically increase the concentration of abrasive river sediments impacting turbine components. This review comprehensively examines the multifaceted nature of silt erosion in hydropower plants, exploring the underlying mechanisms, the detrimental effects on turbine performance, and the available mitigation strategies. A detailed analysis of the factors contributing to silt erosion is presented, encompassing the physical characteristics of the sediment itself—particle size, shape, velocity, and concentration as well as the broader environmental context, including water pH and flow velocity. The influence of each parameter on the erosion rate is carefully considered, providing a nuanced understanding of the complex interplay between sediment properties and hydrodynamic conditions. Furthermore, this review systematically evaluates a range of protective measures currently employed to mitigate the impact of silt erosion on turbine lifespan and efficiency. These measures are assessed based on their efficacy, cost-effectiveness, and practical applicability within diverse hydropower plant settings. The ultimate aim is to provide a thorough overview of the current understanding of silt erosion and its management in hydropower systems, informing the development of more effective and sustainable solutions for enhancing the efficiency and longevity of hydropower infrastructure.

Keywords: Erosion, Hydro-turbine, Coatings

ICAMSF-498

Advancing the Circular Economy Through Additive Manufacturing: Opportunities, Challenges, and Future Prospects

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Abstract
Additive manufacturing (AM), commonly known as 3D printing, is emerging as a transformative technology in advancing the principles of the circular economy. By enabling resource-efficient production, AM minimizes material waste, extends product lifespans, and promotes sustainable design through repair, remanufacturing, and recycling. Unlike conventional subtractive manufacturing, AM allows for precise material deposition, reducing excess waste and energy consumption. Additionally, the use of recycled and bio-based materials in AM contributes to a closed-loop production system, fostering a more sustainable industrial ecosystem. This review explores the role of AM in achieving circular economy goals, focusing on material efficiency, decentralized manufacturing, product life-cycle extension, and waste reduction. Key challenges, including material limitations, energy consumption, and scalability, are also discussed. By integrating AM into circular economy strategies, industries can significantly reduce environmental impact while enhancing economic and operational efficiency. This paper provides a comprehensive analysis of current advancements, challenges, and future prospects of AM in fostering sustainability and resource conservation.

Keywords: Additive Manufacturing, Circular Economy, Sustainability, Recycling, Waste Reduction, Resource Efficiency

ICAMSF-499

Transforming Supply Chains with Additive Manufacturing: Opportunities and Challenges

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Additive Manufacturing (AM) is propelling traditional supply chain into innovation with decentralized manufacturing; reduced lead time; and a lean on inventory costs. Due to on demand production, AM allows for improved agility and resilience of the supply chain against capabilities. This move decreases reliance on global logistics, disperses material waste, and is green. Despite that, high initial investment, quality control and scalability challenges still exist. By passing AM with the further merging technology, such as AI, IoT, and blockchain, there are new approaches for proper, effective supply chain. This paper looks into the key impacts, challenges and future trends of AM on supply chain management.

Keywords: Additive Manufacturing; Supply Chain Optimization; On-Demand Production; Decentralized Manufacturing

ICAMSF-500

A Comparative Analysis of PLA, ABS, and PET in Terms of Sustainability for Additive Manufacturing

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Additive manufacturing (AM) has gained significant attention for its potential to reduce material waste and enable on-demand production. However, the sustainability of the materials used in AM remains a critical concern. This review paper provides a comparative analysis of three widely used thermoplastics—Polylactic Acid (PLA), Acrylonitrile Butadiene Styrene (ABS), and Polyethylene Terephthalate (PET)—evaluating their environmental, mechanical, and economic sustainability. PLA, a bio-based polymer, is biodegradable under industrial composting conditions but has limited recyclability. ABS, a petroleum-derived material, offers superior mechanical properties but poses environmental challenges due to its nonbiodegradability and difficulty in recycling. PET, particularly in its recycled form (rPET), stands out for its high recyclability and lower environmental impact compared to ABS. The paper discusses the carbon footprint, energy consumption, waste management, and end-of-life disposal of each material, highlighting the role of circular economy principles in AM. While PLA is the most environmentally friendly in terms of raw material sourcing, PET emerges as a strong alternative due to its recyclability and industrial scalability. This study underscores the need for continued research into bio-based and recyclable materials to enhance the sustainability of AM.

Keywords: Additive manufacturing, PLA, ABS, PET, sustainability, biodegradable polymers, recycled plastics, circular economy, carbon footprint, waste management

ICAMSF-502

Multibody Simulation of a Collaborative Robot Using Simscape

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In this paper, the multibody modelling and simulation of a collaborative robot is presented. The multibody model of the cobot is developed using the Unified Robotics Description Format (URDF) format to treat the model as a rigid body tree for modelling and simulation in a Simscape Multibody environment. The kinematic configuration of the cobot is generated with the help of Denavit-Hartenberg (D-H) parameters to visualize the robot frames and also to validate with the physical model. Furthermore, the forward and inverse kinematics simulation is performed to determine the pose and joint configuration of the cobot. Furthermore, the torque values required to drive the Simscape multibody model are generated for a given set of waypoints through the trapezoidal trajectory planning.

Keywords: Cobot, D-H parameters, multibody, URDF

ICAMSF-503

Performance Analysis of Alternative Fuel Diesel Blends on Four-Stroke Single Cylinder Compression Ignition Engine - A Comprehensive Review

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The urgent need to mitigate environmental pollution and reduce dependency on fossil fuels has driven significant interest in alternative fuel sources for IC engines. This review examines the performance, emission characteristics, and potential of various alternative fuel diesel blends when used in a 4-stroke single-cylinder CI engine. The review synthesizes findings from numerous studies, providing a comparative analysis of biodiesel, alcohols, vegetable oils, and other novel fuel blends. Performance indicators such as brake thermal efficiency, brake specific fuel consumption, and engine power output are discussed in this article. The review identifies trends in optimizing engine performance and emissions through fuel modifications and highlights the challenges and limitations faced in the practical implementation of these alternative fuels. The potential for future research and development is outlined, emphasizing the need for improved fuel formulations and advanced engine technologies to enhance the viability of alternative diesel blends. This comprehensive analysis aims to provide a foundational understanding for researchers and engineers working towards sustainable and efficient fuel solutions for CI engines.

Keywords: Alternative fuels, Diesel blends, Compression ignition, Performance analysis, Emissions, Sustainable fuels.

ICAMSF-504

Multibody Simulation of a Collaborative Robot Using Simscape

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In this paper, the multibody modelling and simulation of a collaborative robot is presented. The multibody model of the cobot is developed using the Unified Robotics Description Format (URDF) format to treat the model as a rigid body tree for modelling and simulation in a Simscape Multibody environment. The kinematic configuration of the cobot is generated with the help of Denavit-Hartenberg (D-H) parameters to visualize the robot frames and also to validate with the physical model. Furthermore, the forward and inverse kinematics simulation is performed to determine the pose and joint configuration of the cobot. Furthermore, the torque values required to drive the Simscape multibody model are generated for a given set of waypoints through the trapezoidal trajectory planning.

Keywords*:* Cobot, Multibody, Unified Robotics Description, Denavit-Hartenberg (D-H)

ICAMSF-505

Design & Analysis of DG Ball Bearings for Aerospace Applications

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Ball bearings are critical components in aerospace applications, where they must withstand high rotational speeds, mechanical loads, and extreme thermal conditions. This study focuses on the design and analysis of aerospace-grade ball bearings, utilizing Fusion 360 for modeling and ANSYS for structural and thermal simulations. These computational tools provide a comprehensive understanding of the bearing's mechanical behavior under real-world aerospace conditions. The design phase in Fusion 360 involves creating detailed 3D models of the bearing components, including the inner and outer races, rolling elements, and retainers. Material selection is a key aspect of the design process, with aerospace bearings requiring high-strength and thermally stable materials. This study examines AISI 52100, AISI M50, and Nitrided Iron Lithium (NIL) steels, along with ceramic alternatives like silicon nitride (Si_3N_4) and zirconium oxide (ZrO_2), known for their superior heat resistance and low density. Structural analysis using Finite Element Analysis (FEA) in ANSYS is performed to assess the stress distribution and deformation characteristics of the bearings under high mechanical loads. The analysis helps ensure that the bearings maintain structural integrity while preventing material failure. Additionally, thermal analysis examines heat generation, dissipation, and expansion effects at varying operational speeds, ensuring that the bearings can function efficiently under extreme aerospace conditions. The results indicate that hybrid ceramic-metal bearings provide significant advantages in aerospace applications due to their enhanced thermal resistance and reduced structural deformation. The integration of Fusion 360 for design and ANSYS for structural and thermal analysis enables a thorough evaluation of bearing performance, contributing to the development of more reliable and high-performance aerospace components.

Keywords: Aerospace ball bearings, Finite Element Analysis (FEA), Structural and thermal analysis, ANSYS, Fusion 360, High-speed aerospace applications.

ICAMSF-507

Synthesis and Mechanical Characterization of Aluminum Alloy–SiC Nanocomposites through Ultrasonic Assisted Stir Casting Techniques

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Many industries, including aerospace, automotive, defense, and sporting goods, require lightweight materials with outstanding mechanical properties and thermal stability. Al- alloy with nano SiC particles find use in these sectors. In the current work, Al-alloy with nano SiC composites were developed using

the ultrasonic aided stir casting method with varying weight percentages of SiC nano-particles. Using ultrasonification homogeneous mixing of the SiC nanoparticles in the Al alloy was achieved. For the as-cast samples and T6 heat treated samples with various weight percentages of Nano SiC, the various mechanical properties including compressive strength, micro-hardness, impact strength, and tensile strength, among others, have been examined.

Keywards: Al alloy, SiC Nano-Particles, Mechanical Properties

ICAMSF-508

Harmonizing Urban Growth: Balancing Residential and Commercial Needs in Mixed-Use Developments Through Sustainable and Affordable Planning Strategies

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Mixed-use developments are essential in contemporary urban planning by combining housing, commercial, and recreational areas to provide enhanced liveability and economic dynamism. Nonetheless, striking a balance among these elements while providing sustainability, affordability, and user satisfaction is still a major challenge. This research seeks architectural and urban design solutions that maximize land use, induce walkability, and incorporate green building strategies in order to develop sustainable and accessible environments. It reviews examples of successful mixed-use projects and interprets policy tools that enable fair growth. It identifies innovative design strategies, wise zoning policies, and stakeholder participation as driving forces in accomplishing a coherent urban environment. The results feed into a multidisciplinary approach to understanding the ways in which mixed-use planning can promote economic resilience, sustainability, and well-being in quickly urbanizing areas. Mixed-use developments have emerged as an essential instrument for land use maximization, urban sprawl mitigation, and quality of life in general. These developments integrate residential, commercial, and recreational areas in one area, enhancing economic vitality and social vitality. To mitigate rising urban development, cities are gravitating towards dense, compact, and multi-purpose urban patterns. However, the secret lies in achieving balance between residential and business needs, being affordable, sustainable, and gratifying consumers. Architectural and urban planning strategies are responsible for the most fundamental decision-making process of mixed-use development success or failure. Effectiveness of development and aesthetic appeal will improve immensely through good design practices that incorporate walkable buildings along with people-friendly space and green structures.

Keywords: Mixed-use development, Urban planning, Sustainability, Affordability, Architectural Design.

ICAMSF-509

Optimization of Plasma Nitriding parameters to improve surface properties of bearing steels

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Plasma nitriding is a critical surface engineering process used to enhance the mechanical properties of high-performance materials such as AISI M50 bearing steel, which is widely employed in aerospace and automotive applications due to its excellent wear resistance and fatigue strength. This study focuses on

optimizing plasma nitriding parameters—temperature, duration, and gas mixture. To improve the surface hardness of AISI M50 steel. The experiments were conducted using a gas mixture ratio of 20% N_2 and 80% H_2, $_2$, 30% N_2& 70% H_2, 80% N_2& 20% H_2, while varying the temperature (460°C, 500°C, 530°C, 550°C, and 560°C) and duration (4, 8, 12, and 24 hours). The resulting surface hardness was measured using a Vickers microhardness tester, and the data were analysed using Minitab software to identify the optimal parameter combinations. Preliminary results indicate that both temperature and duration significantly influence the hardness of the nitrided layer. Higher temperatures (550°C and 560°C) and longer durations (12 and 24 hours) generally resulted in increased surface hardness due to the formation of a thicker and more uniform nitrided layer. However, excessive temperatures and durations led to diminished returns, potentially due to over-nitriding or microstructural changes. The Minitab software was utilized to perform statistical analysis, including ANOVA and response surface methodology (RSM), to determine the optimal parameter settings for maximizing hardness while minimizing process variability. The findings of this study provide a systematic approach to optimizing plasma nitriding parameters for AISI M50 steel, offering valuable insights for industrial applications. The use of Minitab software enabled efficient data analysis and optimization, ensuring a robust and reliable process. This research contributes to the advancement of surface engineering techniques, enhancing the performance and longevity of critical components in demanding environments.

Keywords: Plasma nitriding, AISI M50 steel, surface hardness, optimization, temperature, duration, gas mixture, Minitab software.

ICAMSF-510

Enhancing Sustainability in Modern Bridge Construction: The Roleof Composite Cantilever Beams in Structural Efficiency andEnvironmental Impact Reduction

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Composite cantilever beams contribute most importantly to augmenting the sustainability of contemporary bridge building through higher structural efficiency, lower material usage, andenhanced durability. Composite cantilever beams, combining sophisticated compositematerials like fiber-reinforced polymers (FRPs) with conventional materials, greatly minimizethe environmental impact through lower resource consumption and carbon emissions. Theirlarge strength-to-weight ratios allow for longer spans with minimized support structures, resulting in cost-effective and energy-efficient bridge designs. Composite cantilever beamsalso provide great corrosion resistance, minimizing maintenance needs and maximizing thelifespan of bridges. This paper discusses the design philosophy, material benefits, andenvironmental advantages of composite cantilever beams, focusing on their role in sustainableinfrastructure development. A comprehensive review of existing literature on composite materials, cantilever beam design, and environment conscious in bridge construction This will include academic papers, industryreports, and case studies to understand the current state of research and pragmatic applicationsof composite cantilever beams in bridge engineering. Different amalgamation of compositematerials (such as steel, concrete, and fiber-reinforced polymers) will be scrutinize for theirstructural properties, including strength, weight, durability, and cost-efficiency. The efficacyof these materials in cantilever beam applications will be studied. This will help assess theirperformance in terms of deflection, stress distribution, and fatigue resistance. This includesquantifying material usage, energy

consumption, emissions, and financing the requirementsthroughout the entire lifespan of a bridge. The analysis will compare the environmental impact of composite cantilever beams to traditional materials like plain concrete or steel. Casestudies of existing bridges that have embody composite cantilever beams will be reviewed. These case studies will help assess the real-world efficacy of these beams in terms ofsustainability, Sustainability metrics such as carbon footprint reduction, resource efficiency.

Keywords: Composite cantilever beams, sustainability, bridge construction, fiber-reinforcedpolymers, structural efficiency, durability.

ICAMSF-511

Experimental Study on the Conductive Properties of a Novel Graphene Nanofluid

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Nanofluids are fluids which contain particles in nanometer range. It is made up of nanoparticles and base fluid. Preparation can be either in one step or two step processes. Nanofluids are used in various fields which include the process of heat transfer mainly in engines, refrigerator, heat exchangers etc. Conductive nanofluids offer wider range of applications in the sphere of engineering and thus we have concentrated our study onto conductive nanofluids. The effectiveness of the properties of nanofluids should be improved in order to keep pace with the demands of the industry. The improved properties are also required to obtain economic viability of nanofluids. As engineers of the 21st century, we have a massive task at hand to keep up the pace of technology with the demands of a rapidly expanding industry. Nanofluids have already shown immense potential as the solution to this problem. Developing a stable, effective and cheap nanofluid which is environmentally responsible can lead to the bolstering of the engineering industry. Although this is an area undergoing vast study right now, there is a need for more comprehensive research. The rising global concern of sustainable development is another motivating factor as engineers can create an environmentally friendly nanofluid. Our research mainly focuses on conductive nanofluids. We used graphene as nanoparticle and jatropha oil as base fluid. Our aim is to prepare a stable nanofluid which can be more economical, efficient and environmentally friendly. The research involves preparation of the nanofluid by ultrasonication, followed by characterization tests such as X-ray Diffraction (XRD) and Redwood viscometer experiment. Finally, testing of the nanofluids in order to analyze conductive properties of the nanofluid.

Keywords Nanofluid, Graphene Nanoparticles, Jatropha Oil, Ultrasonication, Conductive Properties.

ICAMSF-512

Effect of natural cellulose fiber composites towards tribological characteristics

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The growing demand for sustainable and eco-friendly materials has driven the exploration of natural cellulose fiber composites for various engineering applications. This study investigates the tribological characteristics of natural cellulose fiber-reinforced composites, focusing on tribological performance under different loading conditions. The influence of cellulose fiber and surface treatment on the wear rate and friction coefficient was systematically analysed. The results reveal that cellulose fiber composites exhibit improved wear resistance and reduced friction compared to conventional synthetic counterparts due to their unique structural and mechanical properties. Additionally, the incorporation of natural lubricants further enhances the tribological performance, making these composites a promising alternative for applications in automotive, aerospace, and industrial sectors. The study concludes that natural cellulose fiber composites offer a viable and sustainable solution for reducing material degradation and energy loss in sliding and rolling contact systems.

Keywords: Cellulose fiber, Tribology, Composites, Pin On disk

ICAMSF-513

Optimizing Laser Micro-Drilling for Corrosion-Resistant Basalt-Based Marine Composites: A Green Manufacturing Perspective

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Materials used in marine environments face challenges because salty water causes corrosion and the material loses its properties. To address this, a basalt-based marine composite was made using the hand layup method. This composite is rust free as it doesn't contain any metal. Moreover, a multilayered design was used to enhance durability and make it suitable for marine applications. During fabrication, it has been observed that machining these composites is a key challenge as it faces fibre pull out and delamination during machining. To achieve accurate machining, this study used laser micro-drilling to reduce the heat-affected zone (HAZ) and ensure precise hole shapes. Several tests were carried out to find and confirm the best laser process settings for drilling the basalt composite. The results showed that the composite was successfully drilled with minimal HAZ and high-quality holes, making it well-suited for marine use while supporting sustainable manufacturing.

Keywords: Basalt fibre; Marine application; RSM; Genetic Algorithm (GA)

ICAMSF-514

A Comprehensive Analysis of Production Process and Rheological Properties of Biofuel

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Earth's fossil fuel reserves are finite, yet the demand for energy continues to rise. Given the limited availability of fossil fuels and their detrimental environmental impact, many nations are turning to biofuels as a more sustainable energy source. Biofuels, particularly biodiesel, offer a promising solution, as they are carbon-neutral, non-toxic, and environmentally friendly. This paper aims to provide researchers with valuable insights into biodiesel, focusing on its feedstocks, production processes, and the importance of fuel quality verification. The choice of feedstock, production method, and geographical factors all influence the characteristics of biodiesel, which vary from one source to another. Understanding these variables is crucial for ensuring that biodiesel meets the necessary standards for engine use. Additionally, the paper explores the environmental and economic benefits of biodiesel, highlighting its advantages over conventional fossil fuels. By examining biodiesel's role in sustainable development and energy security, the study emphasizes its potential to reduce dependence on non-renewable resources and mitigate the negative effects of fossil fuel consumption. The research also underscores the importance of quality control in biodiesel production to optimize performance and ensure long-term viability. In conclusion, biodiesel offers a viable alternative to fossil fuels, contributing to a cleaner, more sustainable energy future.

Keywords: Sustainable energy, Biodiesel, Transesterification, Catalyst, Physiochemical properties

ICAMSF-515

Investigations on Thermal Performance of Nitrogen-functionalized Graphene - Paraffin Phase Change Material in Finned Heat Sink

Amiya Raju[1], Ebin Baju[1], Bhagya Baburaj[1], Deepak R Menon1, Shijina S S[2], Antony Joseph[2], Mathew Joseph[1] and Vishnu Sankar[1]

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Over the past decade, there has been growing interest in utilizing Phase Change Material (PCM) for electronics management. PCM offers high latent heat, helps in efficient heat absorption and dissipation, making electronic systems suitable for cooling. When exposed to the flux, PCM starts melting without diffusion to the top layers, which can be addressed by adding fins though this may lead to higher overall component weigh.so, thermal enhancement like graphene particles is added to the PCM which has higher thermal conductivity than PCM. But this cannot be directly added due to its weak bond. This will lead to an elevated thermal resistance at the interface between them. To reduce this resistance, nitrogen is

functionalized onto it. This has a stronger interface Various Characterizations like SEM, TEM, Raman Spectroscopy and XRD was done on the composite. The variation in temperature rise is noted for different heat and calculated. At higher heat flux FHS with cPCM was effective by 43.5%. It was found that at lower flux values PCM is found out to be more effective than cPCM. But as temperature increases the effectiveness of cPCM increases. This reduction in enhancement may be caused due to the increased weight ratio of nGO in paraffin. But in general, it can be observed that by the addition of PCM and cPCM the rate of temperature decreases and the time taken to reach the maximum temperature also decreases and it can be concluded that paraffin or phase change material can be used as a passive cooling agent for electronics cooling.

***Keywords*:** Phase Change Material, Passive cooling, Thermal conductivity, Graphene particles, Nitrogen bond graphene.

ICAMSF-516

Synthesis and Comparative Study of CsSnI3 Perovskite Thin Films with PolyVinyl Alcohol as Additive

Sravan Sunil Nair[1], Milan Roy Plathottam[1], Tom G Kazhunnady[1], Saeed Thajudheen[1], Vishnu Sankar[1], Athul Sathyanath[1], Ragin Ramdas[1]

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In recent years many studies have shown promising efficiencies for lead-based perovskites, but due to the concerns about lead toxicity and environmental impact, hinder its large application in the future. The efforts have been made to develop a more environmentally stable lead-free perovskite. CsSnI3 is one such inorganic perovskite that is studied in this research as it offers an appealing lead-free option. Though environmentally unstable, efforts were made to develop the perovskite which is environmentally stable at room temperature with the introduction of additives. The perovskite along with different concentrations of PVA was characterized by thin film XRD to analyze the presence of the perovskite followed by UV-Vis and PL spectroscopy which showed a bandgap of 3.46 eV, 3.44 eV and 3.43 eV. The morphology of the synthesized perovskite was studied using SEM images and the presence of stretching vibration modes was revealed by FTIR spectroscopy at 580 cm-1, 820 cm-1 and 1250 cm-1. Overall, this study contributes to the ongoing efforts to develop stable, lead-free perovskites, demonstrating that the incorporation of additives like PVA can play a crucial role in enhancing their stability and optical properties. These findings offer valuable insights for future research and the potential commercialization of environmentally friendly perovskite materials.

***Keywords*:** X-ray Diffraction, Ultraviolet Visible Spectroscopy, PolyVinyl Alcohol, Scanning Electron Microscope, Fourier Transform Infrared Spectroscopy.

ICAMSF-517

The Aesthetic of Decay: A Study on the use of Biodegradable material for Aesthetics in Architecture

Muskan, Gurkamal Singh, Prateek Dhasmana, Niva Turna[4]
Chitkara School of Planning and Architecture, Chitkara University, Punjab, India
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Over the last few years, biodegradable aesthetics have received enormous attention in the façade of architecture, which in turn challenges the conventional ideas of permanence of the architectural designs. When creating a new architectural design, the effect that the materials used while constructing the new design have on our environment should be taken into consideration and to make that happen this study probes the uses of the biodegradable materials like mycelium, algae-based composites, and rammed earth and embraces the natural decay as an intentional aesthetic element rather than a flaw. The study follows a qualitative approach, critiquing various case studies, material experimentation, and analysing the Japanese concept of 'Wabi-Sabi' which values the imperfections and transience. It can also be noted that expert advice from a diverse set of architects, material scientists and sustainability scientists provide holistic insights into how the biodegradable structures enhance the visual appeal including the texture evolution, organic material transitions, and ecosystem integration. Through this review, the study recognises the emerging technologies, regenerative designs, and the way these new innovations contribute to a new aesthetic paradigm in architecture. The findings reveal that the biodegradable designs have the potential to contribute to sustainability in the architectural world in varied ways. The study introduces a design framework that supports the integration of 'nature' into the architectural designs in the pursuit of sustainability. Moreover, it contributes the discourse on sustainable and ephemeral design, redefining decay as an artistic and ecological tool rather than a sign of neglect. By moving beyond the dominance of permanence in architecture, it opens new possibilities for material innovation, ecological integration, and a reimagined aesthetic of impermanence. The concept of using biodegradable materials provides many inspirations for architectural innovations but it still lacks the explicit design guidelines and strategies that would translate these approaches and successfully incorporate them into the architectural design studies. Furthermore, as integrating biodegradable architecture or rather we should address it as 'nature' into buildings becomes a new marketing strategical tool, the critical factors of biophilic designs must be assessed and given special attention.

Keywords: Biodegradable aesthetics, natural decay, Wabi-Sabi, holistic insights, pursuit of sustainability, ephemeral design.

ICAMSF-518

Scratch behaviour of thin films of WC-10Co-4Cr deposited on CF8M steel

Sanjeev Kumar[a*], Sanjeev Bhandari[b], Manpreet Kaur[b], Vibhu Sharma[c]
[a]IKGPTU, Mechanical Engineering Department, Kapurthala-144603, Punjab
[b]Baba Banda Singh Bahadur Engineering College, Mechanical Engineering Department, Fatehgarh Sahib-140407, Punjab
[c]Chitkara University Institute of Engineering and Technology, Mechanical Engineering Department, Chitkara University, Punjab

In the present work, scratching behaviour of D-gun sprayed WC-10Co-4Cr coating of CF8M steel was investigated. Microstructural flaws and residual stresses impact the scratching resistance of WC-based

coatings in addition to phase composition; hence, the integrity or cohesiveness of these features may provide insight into the scratching behavior of the coatings. With each scratch, constant and ramp loading causes the amount of scratch contact to increase when an appropriate probe is used in parallel. Consequently, ductile microfracture has been generated and controlled plastic strain has accumulated on the surfaces of WC-10Co-4Cr thermally sprayed coatings. The WC-10Co-4Cr coating had more coefficient of friction than the corresponding CF8M steel substrate. The apparent scratch hardness of coated and uncoated steel was calculated from the scratch test readings. Scratch test results on coated and uncoated steel were compared, demonstrating that growing coatings made steel harder and more brittle.

Keywords: Scratch Testing; Coefficient of Friction; Coating; Apparent Scratch Hardness, SEM.

ICAMSF-519

Enhancing Steel Strength through Thermal Coating Techniques

Sanjeev Kumar[a*], Sanjeev Bhandari[b], Manpreet Kaur[b], Vibhu Sharma[c]

[a]IKGPTU, Mechanical Engineering Department, Kapurthala-144603, Punjab

[b]Baba Banda Singh Bahadur Engineering College, Mechanical Engineering Department, Fatehgarh Sahib-140407, Punjab

[c]Chitkara University Institute of Engineering and Technology, Mechanical Engineering Department, Chitkara University, Punjab

A martensitic stainless-steel alloy used in the manufacturing of various components for the oil and gas industry, including valves, pump parts, wellhead equipment, and other tools. Coating is provided to steel materials because of its ability to mechanical properties and durability of the material. Thermal Spraying is mostly used technic for coating the steel surface. To increase the strength of coating and for long-lasting, a detonation gun spraying is used by depositing coatings of Al_2O_3 and WC-CO-Cr, materials known for their unique properties and diverse industrial applications. The coated material is tested through scratching and sliding to know its strength and thickness of coating. Scratching is done to a piece of coated material using TR 101 DUCOM used to test coatings, and manufacturing, to assess the durability and wear resistance of materials and coatings. Sliding friction is done to a small piece of the material. Scanning Electron Microscopy (SEM), a computerized method done to find damage produced by scratch and wear mechanism. Tribometer Pin on Device (POD) is used to strength and wear behaviour of the coating. The values of the scratch are taken under various load conditions to know the ability of the coating. Finally, it is compared with other materials used in different spraying technic to evaluate the performance of the coating.

Keywords: Stainless Steel, Detonation Gun, Thermal spraying, Scratch testing, sliding friction, Scanning Electron Microscopy, Tribometer.

ICAMSF-029

Sustainable Bio-Grease from Palmester Product

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University Transformation Department, University Teknologi MARA (UiTM), 40450 Shah Alam
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Lubricants play a critical role in mechanical systems by influencing the performance of tribological components, which govern friction, lubrication, and wear. Their primary function is to enhance the reliability and longevity of frictional components by acting as anti-friction agents. However, the global lubricant market, primarily dependent on crude oil, faces significant challenges due to the finite nature of this resource. Moreover, the toxic and harmful elements of mineral oils contribute to environmental pollution. Consequently, there is increasing interest in developing innovative, environmentally friendly lubricants, especially for applications exposed to the environment, such as railway systems. Vegetable oil-based lubricants, particularly those derived from palm oils, are emerging as a promising alternative. However, their commercialization is hindered by limitations in properties and performance. To address these challenges, vegetable-derived ester oils have been considered as the best option. This study aims to develop a palm ester-based bio-grease suitable for wheel-rail contact lubrication. It focuses on optimizing the thickener ratio and concentration in the palm ester bio-grease formulation through comprehensive synthesis, analysis, and evaluation of its rheological, physicochemical, and tribological properties. The bio-grease was formulated by dispersing a calcium complex thickener into the palm ester base oil, with $CaCO_3$ and hBN as anti-wear additives. The physicochemical properties were assessed through standard tests for greases, while tribological properties were evaluated using four-ball and pin-on-disc methods. The study found that the ideal thickener concentration of the palm ester bio-grease was 19 wt%, which exhibited the most stable rheological structure, maintaining high viscosity and shear stress across temperature variations. The grease also displayed good viscoelastic behaviour, characterized by strong elastic response up to maximum shear stress. Additionally, incorporating 8 wt% of $CaCO_3$/hBN additives resulted in a grease with an NLGI 000 consistency, a dropping point of 151.7°C, 3.35% water spray-off, and 44.3% oil separation. These properties are comparable to those of a reference rail curve grease. Friction and wear tests demonstrated excellent tribological performance of the palm ester bio-grease. Through the standard wear preventive tests, the friction coefficient value obtained closely aligns with that of commercial grease, and significantly smaller wear scar diameter. The pin-on-disc tests presented a 24% lower in friction coefficient and a 78% lower in pin wear rate compared to the reference grease. These findings provide valuable insights for the development of a palm ester-based bio-grease, incorporating environmentally friendly and cost-effective thickeners and additives suitable for wheel-rail contact lubrication.

Keywords: Anti-Friction Agents, Pin-On-Disc Tests, Wheel-Rail Contact, Anti-Friction Agents.

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ICAMSF-2025
1st International Conference on Advanced Materials for Sustainable Future

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Pre-Conference Webinar

Sustainable Manufacturing: Leveraging Additive Technologies and Materials to Meet SDGs

Speaker

Dr. Binnur Sagbas
Associate Professor & Vice Dean
Faculty of Mechanical Engineering
Yildiz Technical University, Istanbul, Turkey

Key Topics

- Fundamentals of Additive Manufacturing
- Materials Used in Additive Manufacturing
- Additive Manufacturing and Sustainable Development Goals (SDGs)
- Challenges and Future Directions

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1st International Conference on Advanced Materials Sustainable Future (ICAMSF-2025)
28th-29th March, 2025

Organised by
Centre for Research Impact and Outcomes (CRIO), Chitkara University, Punjab

Scan to **Register**

30th
September 2024

Time: 12:00 Noon
Mode: Online

Scan to Join

Expected Audience:
Students/Research Scholars/Faculty Members

Free with prior registration and
E-certificate will be provided to all attendees

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Pre Conference Workshop on

SCIENTIFIC WRITING

Speaker

Priya Vyas

Senior Editor, Springer Nature Group

Contents to be covered

- Writing for International Journals: Structure, Style and Accuracy
- Selecting a Journal for your Manuscript
- Peer Review and you
- Publication Ethics
- Plagiarism, Citations, Open Access
- Avoiding pitfalls

For All Faculty Members
Students & Research Scholars

3rd October, 2024

10:00 AM Onwards

Venue: Pierre Hall (Le Corbusier Block)
Ground Floor, Chitkara University

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Registration Fee: Free
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Pre-Conference Workshop on

Microplastic Era
Microplastic is Everywhere

Speaker

Dr. Chingakham Chinglenthoiba
Assistant Professor
Centre for Research Impact and Outcome
Chitkara University, Punjab

Date : 21st October, 2024
Time : 10:00 AM Onwards
Venue: Pierre Hall (Le Corbusier Block)
Ground Floor, Chitkara University, Punjab

Key Topics

- Issue of Microplastic in Ecosystem
- Health Impact
- Research Opportunities
- Ways to Prevent Microplastic in Food
- Challenges and Future Directions

Registration Fee: Free
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Pre-Conference* Workshop on

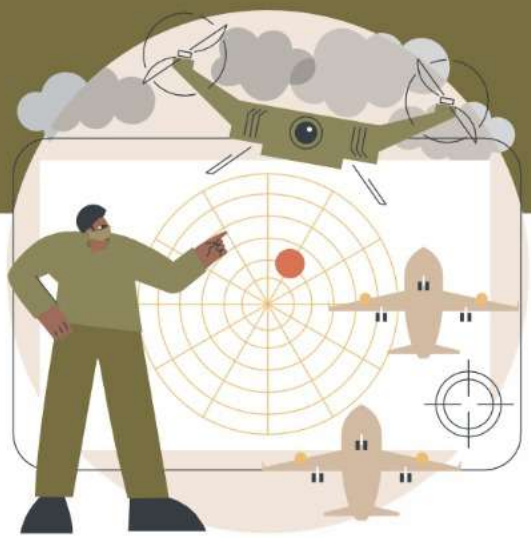
Advanced Materials for Defence Application

Speaker

Dr. R. Santhanam

Senior Scientist "F", Defence Research
and Development Laboratory (DRDL)
Defence Research & Development Organisation (DRDO)
Ministry of Defence, Government of India, Hyderabad

Date : 7th November, 2024
Time : 10:30 AM Onwards
Mode : Online



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Pre-Conference* Workshop on

Viksit Bharat @2047

Speakers

Dr. Rakesh Sehgal

HAG Professor, National Institute of Technology Hamirpur, Himachal Pradesh (Former Director National Institute of Technology Srinagar, J&K)

Title Technology Business Incubators- A Way Forward for Startups

Dr. Anju Batta Sehgal

Fellow Association for Phyto-taxonomy, Member Botanical Society of America, and Society for Ethnobiology USA

Title : Role of Women in Viksit Bharat@2047

Date : 19th November, 2024
Time : 10:00 AM- 1:30 PM
Venue : Pierre Hall (Le Corbusier Block) Ground Floor

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Pre-Conference Webinar on Manufacturing Wonders of Biomaterials

Speaker

Prof. Balasubramanian Kandasubramanian

Senior Professor, Dean (Academics), and Head of Department (Metallurgical & Materials Engineering), Defence Institute of Advanced Technology (DU), Pune, Ministry of Defence, India

Date: 25th November 2024

Time: 10:00 AM Onwards

Mode: Online

Content to be Covered :
Some of the key topics covered during this presentation are:

- Elements of the Biomaterials domain
- Processing of Biomaterials
- Additive manufacturing techniques
- Nanofillers Addition
- Characterization of Biomaterial

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Pre-Conference* Workshop on

MATERIAL

Present, Past, Future

17th December, 2024

Time : 10:30 AM Onwards | **Mode :** Online

Speaker 1

Prof. Mani Kant Paswan
Director
Sant Longowal Institute of Engineering and Technology, Longowal, Punjab

1st International Conference on Advanced Materials for Sustainable Future (ICAMSF-2025) - 28th -29th March, 2025

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Content to be covered
Some of the key topics covered during this presentation are:

- History of Materials
- Material Characterization
- Material Manufacturing-1100 (old manufacturing processes) especially metal material
- Futuristic Materials
- How does the world change due to material outcomes?

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Pre-conference* webinar on

Materials Engineering for Chemical Sensing and Organic Pollutant Degradation

Date : 3rd February, 2025
Time : 11:30 AM Onwards
Mode : Online

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Dr. Pooja Devi

Principal Scientist
CSIR-Central Scientific Instruments Organisation (CSIR-CSIO) Chandigarh
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