CHENNAI RAMAPURAM

SRM

# SMILE 2025

## Proceeding of the ANRF Sponsored International Conference on

# SMART MATERIALS FOR INNOVATION IN LOW CARBON ENERGY AND ENVIRONMENT

**DECEMBER 12th & 13th 2025**


*Edited by*

PROF. HELEN P. KAVITHA
DR. P. ARTHI
DR. T. V. RAJENDRAN



**DEPARTMENT OF CHEMISTRY**
**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**
**RAMAPURAM CAMPUS, CHENNAI**
**&**
**ASSOCIATION OF CHEMISTRY TEACHERS, MUMBAI**

# PROCEEDINGS OF THE

# ANRF SPONSORED INTERNATIONAL CONFERENCE ON

# SMART MATERIALS FOR INNOVATION IN LOW CARBON ENERGY AND ENVIRONMENT

## (SMILE - 2025)

## 12.12.2025 – 13.12.2025

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**Prof.Helen P.Kavitha**

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**Dr.T.V.Rajendran**

*Organized by*

**DEPARTMENT OF CHEMISTRY**

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**RAMAPURAM, CHENNAI - 89**

*in association with*

**ASSOCIATION OF CHEMISTRY TEACHERS (ACT), MUMBAI**

**ANRF SPONSORED**

**INTERNATIONAL CONFERENCE**

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**Faculty of Engineering and Technology**

**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

Ramapuram Campus, Chennai

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**ASSOCIATION OF CHEMISTRY TEACHERS (MUMBAI)**

***CONFERENCE PROGRAMME***

***DAY 1***

| | |
|---|---|
| **8.30 - 09.30 AM** | **Registration** |
| **09.30 – 11.00 AM** | **Inauguration** |
| | **Inaugural Address by Chief Guest**<br><br>**Dr. V. Jayaraman**<br>Director, Materials Chemistry & Metal Fuel Cycle Group, Indira Gandhi Centre For Atomic Research (IGCAR), Kalpakkam |
| | **Special Address by Guest of Honor**<br><br>**Dr. R. Ratheesh,**<br>Director General,Centre for Materials for Electronics Technology ,Under Ministry of Electronics & Information Technology, Govt. of India , Hyderabad |
| | **Lecture by Guest of Honour**<br><br>**Prof. John C. Warner,**<br>President, Technology Greenhouse,USA,<br>Distinguished Professor of Green Chemistry, Movnash University,<br>Australia & Co-Founder of the Field of Green Chemistry |

| | |
|---|---|
| **Photo Session & Tea Break (11.00 - 11.45 AM)** | |
| **11.45 - 12.30 PM** | **Plenary Lecture: 1** |
| | **Chairperson:**<br>**Prof. D. V. Prabu**<br>Former Head, Department of Chemistry<br>Wilson College, Mumbai<br>President, Association of Chemistry Teachers, Mumbai<br>**Rapporteur: Dr. G. Venkat Kumar, Asst. Prof / Chemistry, SRMIST**<br><br>**Dr. V. Ganesh**<br>Senior Principal Scientist, CSIR–Central Electrochemical Research Institute, Karaikudi<br><br>**Title: Sustainable Electrochemical Technologies for Energy and Environmental Applications Through Molecular Engineering of Materials** |
| **12.30 – 1.00 PM** | **Plenary Lecture: 2** |
| | **Dr. Manne Venkateswarlu**<br>Scientific Officer, Midwest Advanced Materials And Energy PVT Ltd, Hyderabad<br><br>**Title: Smart Materials for High-Performance and Sustainable Lithium-Ion Batteries** |
| **Lunch (1.00 - 2.00 PM)** | |
| **2.00 to 2.20 PM** | **Plenary Lecture: 3** |
| | **Dr. Sri Ranjini Arumugam**<br>Director Of Administration, Xeed q (Germany) Leipzig & Ulm<br><br>**Title: Energy efficient Quantum Sensor and Computer: Unleashing the Power of NV centered diamonds** |
| **2.20 to 2.40 PM** | **Plenary Lecture: 4** |
| | **Dr. Brijesh Pare**<br>Past President, Association of Chemistry Teachers, INDIA<br>Professor and Head - Chemistry, Madhav Science Post Graduate College, UJJAIN<br><br>**Title:Circular chemistry for Sustainable Development** |
| **2.40 to 3.00 PM** | **Plenary Lecture: 5** |
| | **Dr. W. B. Gurnule**<br>Visiting Professor, Department of Chemistry, RTM Nagpur University, Nagpur<br><br>**Title: Climatic Change, Corrective Actions and Human Responsibility** |

<table>
<tr><td colspan="2">Tea Break (3.00 to 3.30 PM)</td></tr>
<tr><td rowspan="7">3.30 to 5.00 PM</td><td>Oral / Poster Presentation in Parallel Sessions</td></tr>
<tr><td>Oral Presentation- Session 1 - Off-line Mode/(OP-1 to OP-19)</td></tr>
<tr><td>Session Chairs:<br>Dr. Manne Venkateswarlu<br>Scientific Officer, Midwest Advanced Materials And Energy PVT Ltd, Hyderabad<br><br>Dr. V. Ganesh<br>Senior Principal Scientist, CSIR–Central Electrochemical Research Institute, Karaikudi<br>Rapporteur: Dr. K. Hema / Dr. G. Nithya, Asst. Prof / Chemistry, SRMIST</td></tr>
<tr><td>Oral Presentation- Session 2 - On-line Mode/(OP-39 to OP-65)</td></tr>
<tr><td>Session Chair:<br>Dr. B. R. Venkatraman<br>Associate Professor & Head, Department of Chemistry, Government Arts College, Tiruchirappalli<br><br>Rapporteur: Dr. G. Kaladevi / Dr. S. Sowmya, Asst. Prof / Chemistry, SRMIST</td></tr>
<tr><td>Oral Presentation- Session 3 - On-line Mode/(OP-66 to OP-92)</td></tr>
<tr><td>Session Chair:<br>Dr. Umesh Jain<br>Professor of Chemistry, Pandit Deen Dayal Energy University, Gandhinagar, Gujarat<br><br>Dr. K. Tharani<br>Associate Professor, Department of Chemistry, Government Arts College, Tiruchirappalli<br><br>Rapporteur: Dr. S. Ida / Dr. J. Daisyrani, Asst. Prof / Chemistry, SRMIST</td></tr>
<tr><td>Poster Presentation- Session 1 - Off-line Mode/(PP-1 to PP-50)</td></tr>
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| | |
|---|---|
| | **Session Chairs:**<br>**Dr. W. B. Gurnule**<br>Visiting Professor, Department of Chemistry,<br>RTM Nagpur University, Nagpur<br><br>**Dr. Ganesh Pawar**<br>Principal, N. L. Dalmia College of Arts, Commerce and Science, Mumbai<br>**Rapporteur: Dr. K. Manikandan / Dr. A. Shalini, Asst. Prof / Chemistry, SRMIST** |

***DAY 2***

| | |
|---|---|
| **9.30 - 10.00 AM** | **Plenary Lecture: 6**<br>**Chairperson:**<br><br>**Dr. W. B. Gurnule**<br>Visiting Professor, Department of Chemistry,<br>RTM Nagpur University, Nagpur<br>**Rapporteur: Dr. K. Manikandan, Asst. Prof / Chemistry, SRMIST**<br><br>**Dr. Shankara Gayathri Radhakrishnan**<br>Associate Professor, Department of Chemistry, University of Pretoria, South Africa<br><br>**Title: Nuclear Technology: Energy, Applications and Wealth from Waste** |
| **10.00 to 10.30 AM** | **Plenary Lecture: 7**<br>**Dr. C. V. S. Bramananda Rao**<br>Dean and Professor, Metal Fuel Cycle Group, IGCAR, Kalpakkam<br><br>**Title: From $CO_2$ to multi-Carbon Products: Strategies in Electrocatalysis** |
| **10.30 to 11.00 AM** | **Plenary Lecture: 8**<br>**Dr. R. Kothandaraman**<br>Professor, Department ofChemistry, IIT-Madras<br><br>**Title:Inside the Layered Lattice: Structure–Property Rules for Next-Gen Li-Ion Cathodes** |
| **Tea Break (11.00 to 11.30 AM)** | |
| **11.30 to 12.00 PM** | **Plenary Lecture: 9**<br>**Dr. Ravikumar Ramlu Vidule**<br>Climate Researcher, ChaturvedaPlantech Pvt Ltd, Hyderabad<br><br>**Title:The Carbon Credit Supremacy: India's Blueprint for a Green GDP and Global Economic Leadership through Bio-Intelligent Systems** |

<table>
<tr><td colspan="2">Lunch (12.00 - 1.00 PM)</td></tr>
<tr><td rowspan="5">1.00 to 2.30 PM</td><td>Oral Presentation in Parallel Sessions</td></tr>
<tr><td>Oral Presentation- Session 4 - Off-line Mode/(OP-20 to OP-38)</td></tr>
<tr><td>Session Chairs:<br>Dr. R. Kumaran<br>Associate Professor in Chemistry, D. G. Vaishnav College, Chennai<br><br>Dr. A. Senthil<br>Associate Professor in Physics, SRMIST, Ramapuram, Chennai<br>Rapporteur: Dr. B. Senthil / Dr. G. Venkat Kumar, Asst. Prof / Chemistry, SRMIST</td></tr>
<tr><td>Oral Presentation- Session 5 - On-line Mode/(OP-93 to OP-120)</td></tr>
<tr><td>Session Chairs:<br>Dr. R. Arulmozhi<br>Associate Professor in Chemistry, SRMIST, Kattankulathur, Chennai<br><br>Dr. N. Abirami<br>Associate Professor in Chemistry, SRMIST, Kattankulathur, Chennai<br>Rapporteur: Dr. G. Ushananthini / Dr. E. Pandian, Asst. Prof / Chemistry, SRMIST</td></tr>
<tr><td rowspan="2">2.30 to 3.00 PM</td><td>Plenary Lecture: 10</td></tr>
<tr><td>Dr Ganesh Pawar<br>Principal, N. L. Dalmia College of Arts,Commerce and Science, Mumbai<br><br>Title: Smart & Functional Materials for Energy Storage</td></tr>
<tr><td rowspan="2">3.00 to 3.30 pm</td><td>Plenary Lecture: 11</td></tr>
<tr><td>Dr. Abha Bharti<br>Co-Founder & CTO,Ceratattva Innotech, Chennai</td></tr>
<tr><td colspan="2">Tea Break (3.30 to 4.00 PM)</td></tr>
<tr><td colspan="2">Valedictory (4.00 to 4.30 PM)</td></tr>
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PL 01

# SUSTAINABLE ELECTROCHEMICAL TECHNOLOGIES FOR ENERGY AND ENVIRONMENTAL APPLICATIONS THROUGH MOLECULAR ENGINEERING OF MATERIALS

V. Ganesh

Electrodics and Electrocatalysis (EEC) Division, CSIR – Central Electrochemical Research Institute (CSIR – CECRI), Karaikudi – 630003, Tamil Nadu, India.

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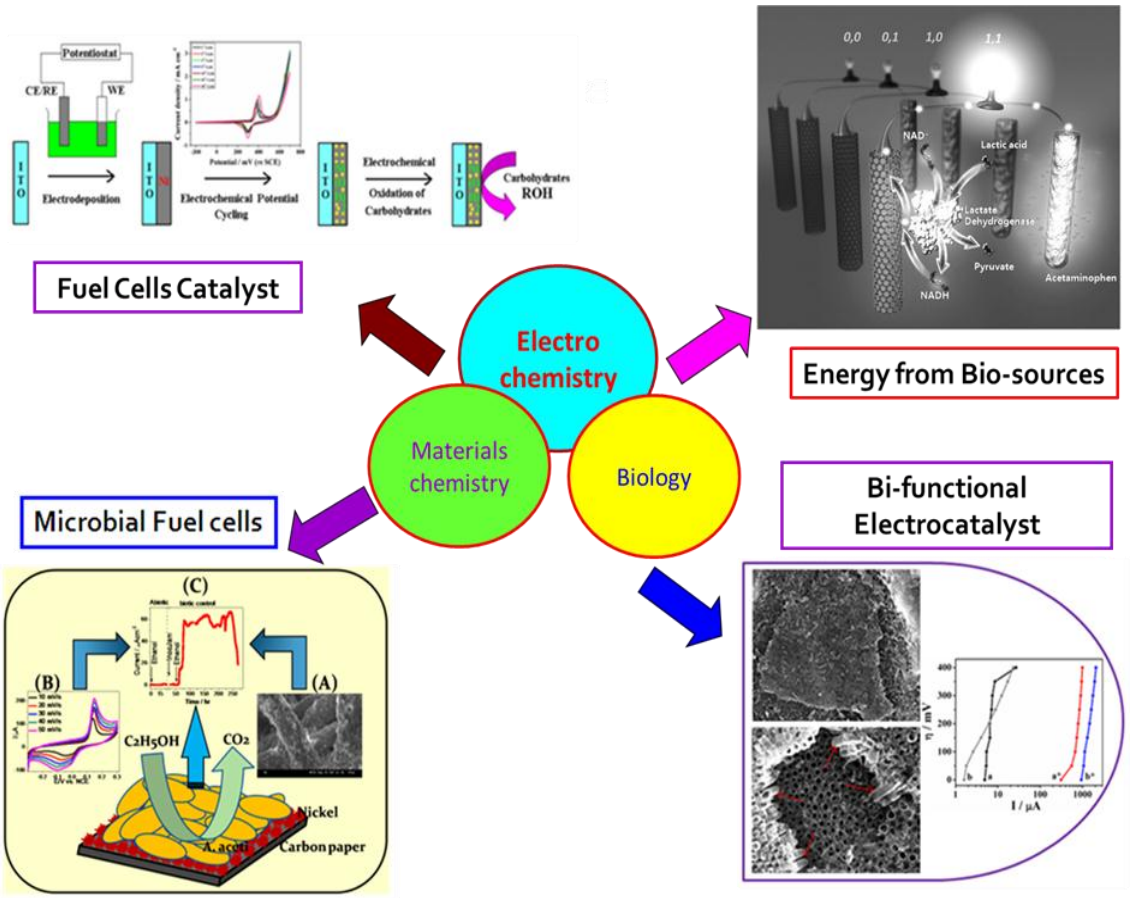
Ever increasing climatic calamities along with modernization of technologies through digitization have forced researchers across the globe to find out alternative materials and methodologies for providing solutions to the global issues. Continued growth of worldwide population in conjunction with highly volatile economics has placed increasing demands for energy and environmental protection at the forefront globally. Need for advanced technologies and ever-increasing use of digitalization even in the under developed and developing nations like India urge researchers to engineer the materials at molecular level for desired applications, especially in the fields of energy conversion & storage processes and environmental protection. Huge expenses associated with the modern-day requirements demand researchers to find out alternative, affordable yet beneficial materials and methods to solve some of the issues associated with energy and environmental sectors. A successful combination of electrochemistry along with materials chemistry can provide wonderful processes that can be used to solve energy crisis and environmental protection. In general electrochemistry in conjunction with materials chemistry offers a simple, cheap, ease to fabricate devices and provide alternative methodology to engineer the system at either atomic or molecular level to impart desired applications. In this context, this lecture will highlight the significance of multidisciplinary approach primarily using electrochemistry and allied fields. Particularly the experiments performed in our laboratory (***Scheme 1***) in order to tune and enhance the electron transport across the electrode – electrolyte interfaces using various chemical modification strategies will be highlighted. Importantly an example each for Fuel cells and microbial fuel cells [MFC] applications will be discussed.

Electrocatalysts developed for direct alcohol oxidation and direct carbohydrate oxidation will also be presented. Moreover, a bi-functional catalyst based on hierarchically ordered nanoporous $TiO_2$ electrodes developed for water splitting reaction thereby simultaneous evolution of oxygen and hydrogen will also be discussed. Further, immobilization of microbes onto high surface area electrodes leads to specific catalytic activity of the prosthetic groups of enzymes present within the microbes which in turn demonstrated to be the potential anodes for microbial fuel cells applications. Moreover, some of the recent developments made at our laboratory in the area of flexible electrodes as bioenergy conversion platforms for generation of energy from biochemical reactions and from human excretory fluids will be highlighted. Finally, flexible strip-based sensor developed for the selective and sensitive detection of pesticides will also be discussed. In all these applications, electrochemistry is demonstrated to be a simple yet powerful technique to generate and convert renewable energy using modified interfaces formed through engineering of materials.




***Scheme 1:*** Pictorial representation of the fabrication of new and smart materials for energy conversion & storage and environmental related applications through electrochemical technologies.

# SMART MATERIALS FOR HIGH-PERFORMANCE AND SUSTAINABLE LITHIUM-ION BATTERIES

Manne Venkateswarlu
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The global transition toward low-carbon energy systems demands lithium-ion batteries (LiBs) with higher performance, longer life, and significantly reduced environmental impact. This paper presents a comprehensive overview of smart-material strategies, nano-architecture electrodes, engineered interfaces, and multifunctional cathode systems including high-voltage spinels, Mn-rich/Co-lean layered oxides, and stabilized olivine structures, optimized through surface modification, dopant engineering, and advanced material design. These material innovations are evaluated alongside modern Li-ion cell-manufacturing approaches inherited from consumer electronics and adapted for cylindrical, pouch, and prismatic cell formats.

A comparison of electrode-processing steps, slurry mixing, coating, drying, calendaring, and vacuum dehydration, highlights the pivotal influence of binder–solvent systems on manufacturing energy consumption and carbon footprint. Conventional cathode processing relies on PVDF binders dissolved in N-methyl-2-pyrrolidone (NMP), a toxic organic solvent requiring high-temperature drying and energy-intensive solvent-recovery units, thus contributing substantially to $CO_2$ emissions. In contrast, anodes commonly utilize water-based CMC–SBR binder systems. This water-based route eliminates hazardous solvents and drastically lowers drying energy and overall process emissions. Emerging dry-electrode manufacturing techniques are also discussed, which eliminate solvents entirely, reduce energy consumption by up to an order of magnitude, and enable cleaner, faster, and more scalable electrode fabrication. These advances are complemented by the development of solid-state battery architectures, where solid electrolytes and solvent-free electrode integration enhance safety, thermal stability, and achievable energy density.

Electrochemical assessments confirm that the integration of smart materials with advanced manufacturing produces Li-ion cells exhibiting higher specific capacity, improved thermal resilience, and longer cycle life. These combined strategies enable LiBs to meet next-generation requirements across e-Mobility, renewable-integrated battery-energy storage systems (BESS), drone propulsion, and the emerging domain of solid-state Li-ion technologies.

# ENERGY EFFICIENT QUANTUM SENSOR AND COMPUTER: UNLEASHING THE POWER OF NV CENTRED DIAMONDS

Sri Ranjini Arumugam
Director of Administration, XeedQ GmbH, Leipzig, Germany
sri@xeedq.com

Undoubtedly, its sparkling nature is the primary reason for attraction towards diamond since prehistoric times. Nevertheless, the superior hardness and the ability to cut and scratch materials are also well known since ages. Modern science added some more credits to diamond's outstanding properties, among them are high refractive index and highest thermal conductivity to name a few. It is an astonishing fact that all these extraordinary properties of diamond arise just because of the crystalline network of carbon atoms that are chemically bonded in a tetragonal geometry (sp3 hybridization). In the search for sustainable and powerful quantum technologies, diamond emerges as a game-changer. Interestingly, during the past 15 years, scientists found that an atomic flaw in this otherwise perfect crystalline material is unique and has the potential to be used as elegant sensors to get insights into the properties and interactions of materials at scales where their quantum natures dominate. One such flaw is Nitrogen-Vacancy (NV) defect. This defect in the diamond crystal is created by replacing one atom of carbon with one atom of nitrogen while the neighbouring atom is left vacant purposely. This NVD is emerging as a jewel in the realm of quantum technology and focus research area and has displayed a remarkable progress. This system offers great potential for realizing futuristic energy efficient applications in nanoscience, benefiting a range of fields from bioimaging to quantum-sensing and quantum computing. The ability to image single NV colour centres in a nanodiamond and manipulate NV electron spin optically under ambient condition is the main driving force behind developments in nanoscale sensing and novel computing techniques. In this talk, I will discuss the current status with a few applications of NV diamond such as single molecule spin imaging, temperatures in cellular environment, multiplexing and quantum processors.

**References:**

1) G.Balasubramanian et.al Nature 455 (7213), 648-651,2008.
2) G.Balasubramanian et.al Current opinion in chemical biology 20, 69-77,2014.
3) D.Duan et.al Applied Physics Letters 116 (11), 113701,2020.
4) https://xeedq.com/

# CIRCULAR CHEMISTRY FOR SUSTAINABLE DEVELOPMENT

Brijesh Pare
Past President, Association of Chemistry Teachers, India ( 2020- 2024)
Department of Chemistry, Madhav Science PG College UJJAIN MP
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The challenges looming over the humans are tremendous, extreme poverty, little access to potable water & fresh food; millions die from diseases transmitted by viruses, bacteria, protozoa and fungi, and rising of the oceans' levels; millions of people are forced to leave their homes and cities by wars and conflicts, unemployment, is increasing, especially in countries where production processes have become more automated and less dependent on human labor; the extensive exploitation of the planet's natural resources and the generation of huge amounts of waste have severely affected the quality of air, soil, and water bodies. To deal effectively and smartly with the worsening environmental crises, chemistry needs a few alterations, a redesign. There is an urgency for a triple focus on efficiency, safety and circularity as a condition for chemistry to serve sustainability and ensure that essential chemical products and processes are waste-free, functional and safe for both humans and the environment. Circular chemistry (CC) is an approach for making chemical processes truly circular and sustainable. It takes into consideration the principles of circular economy (CE), employing life cycle approaches and systems thinking, which help to comprehend and tackle the sustainability issues of chemical processes and products. In this context, it is possible to identify some problems of the current lifestyle, such as plastic waste disposal, CO2 emission, e-waste. The reuse provided, well-structured within the context of circular chemistry, can bring benefits in all spheres: social, environmental and economic. Thus, the purpose of this revision is to present CE and CC as the pillars for a sustainable development, bringing discussions about: CE and CC systems; sustainable chemistry and chemistry 4.0, which embeds digitization, sustainability, and circular economy in industrial chemical processes. Through the knowledge of chemistry, both CC and CE can contribute with innovative methods and processes which maximize benefits, eliminating, or, at least, reducing adverse impacts, thus contributing to construct a mutually beneficial relationship between science and society, its surroundings, and the environment. Therefore, implementing this new model is an opportunity that challenges the human imagination in building a better world. Circular

chemistry offers a holistic systems approach: by making chemical processes truly circular, products can ideally be repurposed near-indefinitely, with energy as the only input. The chemical sector has the opportunity to take a leading role in combatting scarcity and environmental crises as a result of ineffective waste management, as the development of novel chemical reactions to reuse molecules and materials will lead to a closed-loop chemical industry. Life cycle thinking and circularity will reinvent chemistry, and should be the basic principles for developing novel chemical products and processes that use waste as resource. In turn, this will contribute to achieving the circular economy and securing sustainable future by addressing the United Nations Sustainable Development Goals. Its high time and of an utmost importance to replace the classical model of the linear economy.

**Reference:**


1. Teodoro S. Kaufman , J. Braz. Chem. Soc., Vol. 33, No. 12, 1353-1374, 2022 ©2022
2. Tom Keijer, Vincent Bakker and J. Chris Slootweg, Nature Chemistry | VOL 11 | MARCH 2019 | 190–195

# CLIMATIC CHANGE, CORRECTIVE ACTIONS AND HUMAN RESPONSIBILITY

W. B. Gurnule

Department of Chemistry, RTM Nagpur University, Nagpur-440033, India

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Advanced sustainable materials are among the most challenging areas of current scientific and technological research because of the variety of interesting changes in their properties at nano-dimension. Chemistry is central science. It provides fundamental understandings needed to deal with many societal needs including many that determine our quality of life and our economic strength. The backbone for a sustainable development is science and Technology. Science and technology are different but at the same time complementry to each other. Materials are the backbone of any technological development. It is rightly said that those who control materials control technology. Fabrication of functional advanced sustainable materials has become a challenge and recent research is mainly focused on the development of modified oxides for multiple applications.

Sustainable material like g-$C_3N_4$-TDA have been synthesized in presence of methanol and stirred at $90^0$C using carbon nitride and 2, 5-thiophene dicarboxylic acid. The material play a crucial role in global environmental challenges. These materials are designed to minimize ecological impact throughout the life cycle from extraction and production to use, reuse, and disposal. Further enhances sustainability by extending product lifespans, reducing waste and carbon dioxide from the atmosphere. Electrochemical Capacitive Behaviour of the materials have also been carried out. $CO_2$ photoreduction activity using Ph-g-$C_3N_4$ and Ag/AgO-g-$C_3N_4$ microspheres materials also synthesized and use for sustainability. We have to modify our lifestyle/attitude and consumption habits to reduce burden on the earth and we have to adopt non-materialistic pattern of behaviour. If we don't care for nature our planet, natural calamities are bound to hit us.

# `FROM $CO_2$ TO MULTI-CARBON PRODUCTS: STRATEGIES IN ELECTROCATALYSIS

Shankara Gayathri Radhakrishnan

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The electrochemical reduction of carbon dioxide ($CO_2$RR) offers a promising pathway to mitigate rising atmospheric $CO_2$ levels by converting this greenhouse gas into valuable chemical feedstocks and renewable fuels, such as carbon monoxide, formic acid, methane, ethylene other valuable fuels. This process utilizes electrical energy, often generated from renewable sources, to drive the $CO_2$ conversion on the surface of a catalyst however hindered by several challenges, primarily the high overpotential required to initiate the reaction, the poor product selectivity due to competing side reactions (such as the hydrogen evolution reaction, HER), and the limited stability of current electrocatalysts. This talk will focus on catalyst design to control the reaction pathways, lower the energy input, and achieve high faradaic efficiency towards single, high-value products. Success in these areas is critical for scaling $CO_2$RR technology from laboratory proof-of-concept to industrial viability, contributing fundamentally to a circular carbon economy.

# INSIDE THE LAYERED LATTICE: STRUCTURE–PROPERTY RULES FOR NEXT-GEN Li-ION CATHODES

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Nickel-rich layered oxide cathodes have emerged as one of the leaders for next-generation lithium-ion batteries (LIBs), offering high energy density and a relatively lower cobalt content. However, challenges such as cation mixing, structural degradation, and poor cycle retention persist. In this study, we systematically investigate the effect of controlled manganese (Mn) substitution in a NCA cathode materials synthesized via a solid-state route, targeting enhanced structural and electrochemical stability. XRD, Rietveld and TEM analyses confirm single-phase layered α-NaFeO□-type structures with decreasing phase purity and increasing c/a ratios at high Mn content ($x \geq 0.2$), indicating an increased cation disorder in the samples with increasing Mn contents. Mn introduction affects oxidation states of both Ni and Co leading to defects in the structure. Besides, due to Jahn-Teller distortion, particles undergo pulverization with the introduction of Mn. The presence of excess of Mn on the particle surface is confirmed with EELS. The sample with $x = 0.1$ (NMCA-1) demonstrated the optimal balance, exhibiting minimal lattice strain (0.0004%), the smallest crystallite size (~50 nm), and comparable structural integrity with an I(003)/I(104) ratio of 1.25. Electrochemically, NMCA-1 delivered the highest capacity retention (~85% after 100 cycles at 0.2C), outperforming both undoped NCA (~70%) and fully Mn-substituted NMA (~45%). Despite a slight reduction in initial capacity (137 mAh g□¹), NMCA-1 exhibited superior rate capability (77 mAh g□¹ at 2C) and reduced overpotential growth, confirmed by CV and EIS analyses. Our findings highlight the synergistic effect of Mn and Al co-doping in optimizing cathode performance by tuning structural strain, mitigating phase degradation, and enhancing long-term cycling behaviour. This approach offers a cost-effective and scalable strategy to engineer high-performance cathode materials for future LIB applications.

**References:**

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# THE CARBON CREDIT SUPREMACY: INDIA'S BLUEPRINT FOR A GREEN GDP AND GLOBAL ECONOMIC LEADERSHIP THROUGH BIO-INTELLIGENT SYSTEMS

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As the world enters an era where economic power is inseparable from climate responsibility, India stands at a historic inflection point. This invited talk presents a bold yet scientifically grounded proposition: India can emerge as the world's foremost economic leader not by replicating conventional growth models, but by architecting a Bio-Intelligent Carbon Economy that monetizes its vast agro-ecological wealth through verifiable, technology-driven carbon credits.This presentation unveils a transformative national framework—a "Green GDP" paradigm—that redefines trees, soil systems, and rural landscapes as high-value, globally tradable sustainability assets. Through this shift, carbon becomes not merely an environmental commodity but a cornerstone of sovereign economic strategy.

## Smart Materials × Bio-Intelligence: Engineering the Next Carbon Economy

The proposed **Bio-Intelligent Carbon Sequestration (BICS)** ecosystem integrates frontier materials science, regenerative agroecology, and AI-driven climate finance. Anchored in the conference's thrust areas, the blueprint incorporates:

- **Nano-Catalyzed Soil Intelligence**
  Utilization of nanostructured and bio-inspired smart materials to enhance soil carbon capture, accelerate microbial activity, and significantly surpass conventional sequestration efficiencies—directly aligning with innovations in Nanostructured and Bio-Inspired Materials.
- **Decarbonisation Infrastructure for Rural Economies**
  Development of advanced polymer composites, hybrid materials, and low-cost CO□ utilization systems to strengthen India's distributed carbon economy—supporting the mission of Low-Carbon and Renewable Energy Solutions.
- **AI-Driven MRV and Financial Sovereignty**

Integration of the *AgroNeuro* predictive platform to build a tamper-proof, satellite-synced MRV system compliant with Verra VCS standards (including AR-AMS0007). This ensures integrity, transparency, and sovereign control over carbon asset verification, positioning India as the global benchmark for digital climate finance.

- **Green Wealth Revolution: Reimagining India's Economic Command**

  The keynote articulates how this BICS-powered "Tree-to-Credit" model transforms millions of rural farmers into climate entrepreneurs, generating decentralized wealth at a scale capable of reshaping India's national GDP. By establishing the most scientifically credible, digitally auditable, and socially inclusive carbon credit ecosystem, India can set the global gold standard for carbon markets.

  The talk concludes with actionable policy pathways that position India as the undisputed leader of the emerging Green Economic Order, enabling the nation to achieve Net-Zero ASAP while simultaneously accelerating economic growth, rural upliftment, and global climate leadership.

# SMART & FUNCTIONAL MATERIALS FOR ENERGY STORAGE

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We are facing global energy crisis due to rapid exhaustion of fossil fuels. Hence, the renewable and inexhaustible sources of energy and its storage are the urgent need of the time. The immediate focus is centred on the Sun and the Hydrogen Gas as the alternative sources of energy. Now, rather than harnessing solar and hydrogen gas energy, the main challenge being faced is the appropriate storage of energy trapped. This challenge has opened up a new field in material sciences to develop smart and functional materials for energy capturing, storing and discharging. Metal Hydrides, Metal Organic Frameworks (MOFs) and Covalent Organic Frameworks (COFs) are emerging as good candidates for hydrogen storage. Similarly, conversion of abundant solar energy into electrical energy and its storage on large scale are being explored by using a variety of novel materials like Lithium ions, solid state ceramic electrolytes, Li-S /Li-Air batteries, Na+/Na-S batteries, Li-Transition metals complexes, Graphene, Carbon nanotubes, Proton Exchange Membranes (PEMs), Pt-free catalysts, molten salts, new age polymers and a variety of nanoparticles. In the next decade, sustained scientific efforts, coupled with computational approaches, will accelerate novel materials discovery for optimization of energy harnessing, storing and using.

# ORAL PRESENTATION

**OP 01**

# SUSTAINABLE PRODUCTION OF BIO-ASSISTED $SnO_2$ NANOPARTICLES FROM *LITCHICHINENSIS* SEED BIOMASS FOR ADVANCED FUNCTIONAL APPLICATIONS

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Green synthesis provides an environmentally friendly and resource-efficient approach for producing functional nanomaterials. In this study, tin oxide ($SnO_2$) nanoparticles were synthesized using Litchi chinensis seed extract, which acted as a natural reducing and stabilizing agent. The resulting $SnO_2$ nanoparticles were systematically characterized by XRD, FTIR, and UV-Visible spectroscopy to evaluate their structural, surface, and optical properties. Employing fruit-waste biomass as a precursor demonstrates a sustainable and cost-effective route for generating semiconductor nanomaterials with bio-derived surface functionalities. The green-synthesized $SnO_2$ nanoparticles exhibit favourable characteristics for integration into multifunctional and emerging technological applications. Furthermore, they form a strong basis for developing next-generation composite systems, such as $SnO_2$/biochar hybrids, offering enhanced performance in environmental remediation, sensing, photocatalysis, antimicrobial activity, and functional coatings. Overall, this study establishes a sustainable synthesis strategy and highlights the potential of bio-assisted $SnO_2$ nanomaterials for high-performance, composite-based applications.

**Keywords:** Tin oxide nanoparticles, Litchi chinensis, Environmental remediation, Bio-assisted synthesis.

**OP 02**

# ENGINEERING INTRINSIC WHITE-EMISSIVE CARBON DOTS AS PHOSPHORS FOR WHITELED APPLICATION

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Carbon dots (CDs) are zero-dimensional, carbon-rich nanomaterials known for their strongphotoluminescence arising from quantum confinement. Their facile synthesis, low cytotoxicityand tunable physicochemical characteristics have further increased their appeal. In the contextof modern solid-state lighting, developing single component white-emissive CDs that canfunction as efficient white phosphors is highly desirable, particularly for cost-effective LightEmitting Diode (LED) applications. Although rare-earth-doped phosphors are capable ofproducing white light, their complex fabrication routes, high expense, and potentialenvironmental or biological hazards limit their practical utility. To address these challenges,we developed a reproducible one-step hydrothermal route for synthesizing white-light-emittingCDs from amino acids under pH-regulated conditions. The resulting CDs displayed a broadphotoluminescence profile with maximum emission around 450 nm. To construct a colour-conversion phosphor layer while suppressing aggregation-induced quenching, the CDs wereincorporated into an appropriate polymer matrix and subsequently integrated with a 365 nmUV LED. The fabricated CD-based film demonstrated excellent stability for up to 300 days atambient temperature and exhibited a prolonged fluorescence lifetime of 18.6 ns. Remarkably,the device achieved a high Colour Rendering Index (CRI) of 86%, producing cool-whiteillumination with chromaticity coordinates of (0.302, 0.318) and a Correlated ColourTemperature (CCT) of 7236 K, lying close to the Planckian locus. These nitrogen-rich whiteCDs derived from amino acids present a promising pathway for developing metal-free, efficient, and economical phosphor materials for cool-white LED technologies and otheroptoelectronic applications.

**Keywords:** White phosphor, Light emitting diodes, Carbon dots, Amino acids, Hydrothermal, Photoluminescence

**OP 03**

# ENHANCED PHOTOCATALYTIC AND ANTIBACTERIAL PERFORMANCE OF Cu and Fe CO-DOPED ZnS NANOPARTICLES

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Zinc sulphide (ZnS) is a wide bandgap semiconductor (3.54-3.91 eV) with tunable optoelectronic characteristics, making it an attractive material for diverse technological applications. However, its large bandgap restricts visible-light absorption, thereby limiting its performance in photocatalytic processes. In this study, we introduce a dual-transition-metal doping strategy involving copper (Cu) and iron (Fe) to enhance the photocatalytic and antibacterial efficiency of ZnS nanoparticles (NPs). Pure ZnS, Cu-doped ZnS (Cu:ZnS), and Cu-Fe co-doped ZnS (Cu: Fe: ZnS) nanoparticles were synthesized via a simple and efficient chemical co-precipitation method using 2-mercaptoethanol (2-ME) as a stabilizing agent. The synthesized nanoparticles were thoroughly characterized using multiple analytical techniques. X-ray diffraction (XRD) and scanning electron microscopy (SEM) confirmed the crystalline structure and morphological features of the samples. Optical analyses using UV-Vis spectroscopy revealed a significant reduction in the bandgap energies of Cu: ZnS and Cu: Fe: ZnS by approximately 0.78 eV and 0.62 eV, respectively, compared to pure ZnS. Fourier-transform infrared (FTIR) spectroscopy identified the functional groups present, while Raman spectra supported the XRD findings. Brunauer–Emmett–Teller (BET) measurements showed an increase in surface area to 80.54 $m^2/g$ for Cu: ZnS and 133.31 $m^2/g$ for Cu: Fe: ZnS, relative to undoped ZnS. Antibacterial activity, evaluated using the agar disc diffusion method, revealed enhanced bactericidal properties for both doped systems. Furthermore, photocatalytic tests on Rhodamine 6G (Rh6G) under visible light illumination showed that Cu: Fe: ZnS nanoparticles achieved the highest degradation efficiency of approximately 83.7%, underscoring their potential as efficient photocatalysts.

**OP 04**

# GREEN SYNTHESIS OF SILVER NANOPARTICLES DECORATED ONTO CLAY COMPOSITES USING PLANT EXTRACTS AND THEIR BIOLOGICAL ACTIVITIES

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In this study, microwave-assisted, optimised kaolinite clay incorporated AgNPs have been reported. Here, the *Syzygium cumin* plant root extract acts as a reducing and capping/stabilising agent. The phytochemicals of *Syzygium cumin* extract stuck or attached to the surface of AgNPs. kaolinite has negative charge, -OH group and a high adsorption capacity for these freshly formed AgNPs stick to the surface of kaolinite. The synthesised nanocomposites were characterised by UV–Visible spectroscopy (UV-Vis), Fourier transform infrared spectroscopy (FTIR), powder X-ray diffraction (XRD), thermogravimetric analysis (TGA) and scanning electron microscopy (SEM). The *nanoc*omposite exhibited better biological activities like antimicrobial activity, anti-diabetic, anti-cancer, anti-inflammatory, anti- oxidant properties. Their antioxidant and anti-inflammatory activities were assessed using the DPPH (2,2-diphenyl-1-picrylhydrazyl) free radical scavenging assay, the phosphomolybdenum (PM) total antioxidant assay, and the albumin denaturation assay. The antibacterial potential of the nanoparticles was further evaluated against both Gram-positive and Gram-negative bacteria using the agar well diffusion method. In addition, the antidiabetic activity of the nanoparticles was determined through α-amylase and α-glucosidase enzyme inhibition assays.

**Keywords:***Syzygium cumin*, kaolinite, Photo chemicals, AgNPs, anti- oxidant, anti-diabetic.

**OP 05**

# GREEN SYNTHESIS, BIOLOGICAL ACTIVITY AND PHARMACEUTICAL EFFLUENT DEGRADATION USINGMETAL NANOPARTICLES

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The growing demand for eco-friendly and sustainable nanomaterial production has led to an increased focus on green synthesis methods. In this study, Zr02 nanoparticles were synthesized using a plant extract as a natural reducing and stabilizing agent and prevent agglomeration, eliminating the need for hazardous chemicals. This green approach not only reduces environmental impact but also enhances the biocompatibility of the resulting nanoparticles, making them suitable for biomedical and therapeutic applications. The synthesized nanoparticles were characterized using various analytical techniques, including LIV —Visible spectroscopy, Fourier Transform Infrared Spectroscopy (FTIR), X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM) and Energy Dispersive Spectroscopy (EDS). UV-Visible analysis confirmed the successful formation of nanoparticles with characteristic absorption peaks, FTIR spectra revealed the presence of functional groups from plant phytochemicals responsible for reduction and stabilization, SEM micrographs showed uniform morphology and well-dispersed particles. The green-synthesized nanoparticles demonstrate promising potential for biomedical applications due to their non-toxic, eco-friendly synthesis route and the presence of bioactive phytoconstituents that may enhance biological com partibility. These nanoparticles are particularly significant in anti-cancer and drug delivery research, offering a sustainable alternative to chemically synthesized nanomaterials. The study emphasizes that green synthesis using plant-based methods can provide a cost-effective, renewable, and safe pathway for the large-scale production of nanoparticles with potential bio medical importance.

**Keywords:** Green synthesis, Cost-effective, Eco-friendly, Biocom partibility.

**OP 06**

# A NOVEL SYNTHESIZED OF $ZrO_2$-SrO@$SiO_2$-CR FOR THE DETECTION OF $Pb^{2+}$ & $Cd^{2+}$ In WATER SAMPLE WITH ANODIC STRIPPING VOLTAMMETRY

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To fabricate the selective $Pb^{2+}$& $Cd^{2+}$ ions sensor, a slurry of the synthesized of $ZrO_2$-SrO@$SiO_2$-CR (Congo red) was deposited on paraffin graphite electrode (PGE). The core shell structure Congo red composite nanoparticles ($ZrO_2$-SrO@$SiO_2$-CR) was synthesised under co-precipitation method. The $ZrO_2$-SrO@$SiO_2$-CR that was synthesized is verified using Fourier Transform infrared spectroscopy (FT-IR), X-ray diffraction (XRD), Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray Spectroscopy (EDAX) and X-ray photo electron spectroscopy (XPS) were used to analyse the surface morphology of $ZrO_2$-SrO@$SiO_2$-CR-$M^{2+}$, $ZrO_2$-SrO@$SiO_2$-CR and PGE electrodes were confirmed for conductivity using cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS). $Pb^{2+}$& $Cd^{2+}$ ions were examined using square wave anodic stripping voltammetry (SWASV) on $ZrO_2$-SrO@$SiO_2$-CR and PGE electrodes. During sensing performances, the $Pb^{2+}$& $Cd^{2+}$ sensor with active CR exhibits stability, perfect reproducible results, interference, and stability. Above all, successive applicability to the detection of water samples was demonstrated. Atomic absorption spectroscopy (AAS) measurements are correlated with those of the water samples.

**Keywords:** Chemically modified electrode, $ZrO_2$-SrO@$SiO_2$-CR and $Pb^{2+}$& $Cd^{2}$.

**OP 07**

# NON-ANTIMICROBIAL, ANTIOXIDANT AND ANTICANCER ACTIVITY OF GREEN SYNTHESIZED Zr NANOPARTICLES BY USING *PELTOPHORUM PTEROCARPUM* FLOWER

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Nanoparticles, known for their distinctive physicochemical and biological properties, haveattracted great interest for applications in medicine, catalysis, and environmental science, withgreen synthesis emerging as an eco-friendly and sustainable alternative to conventionalmethods by avoiding toxic reagents and harsh conditions. In the current study, *Peltophorum pterocarpum* flower extract was used as a natural reducing and stabilizing agent to synthesiszirconium (Zr) nanoparticles. A number of spectroscopic and microscopic investigations wereused to confirm the synthesis and properties of the synthesized Zr nanoparticles. UV–Visiblespectroscopy displayed a characteristic absorption band confirming nanoparticle formation,while FTIR spectroscopy revealed the presence of phytochemical functional groups involvedin the reduction and stabilization process, along with a distinct Zr–O stretching vibrationobserved at 680 $cm^{-1}$, confirming the successful formation of zirconium nanoparticles. GC–MS analysis identified 13 bioactive compounds in the extract responsible for nanoparticlestabilization. X-ray diffraction (XRD) patterns confirmed the crystalline nature of thenanoparticles with a tetragonal phase and an average crystallite size of 5.8 nm as calculatedusing the Debye–Scherrer formula. Field Emission Scanning Electron Microscopy (FESEM)images revealed that the Zr nanoparticles were predominantly spherical in shape.

Theantimicrobial activity was evaluated against six strains, while the antioxidant potential wasdetermined using DPPH and FRAP assays, and the anticancer activity was assessed againsthuman breast cancer cells (MCF-7) using the MTT assay. The results showed negligibleantimicrobial, anticancer activity and antioxidant activity, suggesting that the nanoparticlespossess minimal intrinsic bioactivity. Such biocompatible and stable behaviour makes thesegreen-synthesized Zr nanoparticles promising candidates for targeted drug deliveryapplications, where controlled reactivity and non-toxicity are highly desirable.

**OP 08**

# ECO-ENGINEERED NiO NANOSTRUCTURES FOR PHOTOCATALYTIC DYE DEGRADATION, ANTIMICROBIALACTIVITY, CYTOTOXICITY, ANTIOXIDANT APPLICATIONS AND SUPERCAPACITOR PERFORMANCE

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This work describes the green one-pot method of producing nickel oxide nanoparticles (NiO) fromplant extract. The p-type wide band gap semiconductor nickel oxide (NiO) has garnered a lot of interestbecause of its exceptional chemical stability, environmental friendliness, and adjustable electricalcharacteristics. NiO's strong visible-light absorption, high hole mobility, and capacity to formheterojunctions with other semiconductors to improve charge separation efficiency make it anexcellent candidate for photocatalytic applications in pollutant degradation, water splitting, and solar energy conversion. NiO is acknowledged as a promising electrode material for supercapacitors inenergy storage due to its high theoretical capacitance, reversible redox activity, and structural stability.NiO's surface area, ion transport pathways, and electrochemical activity are all further enhanced by itsnanostructuring, which includes nanoflakes, nanorods, and porous films. In order to concurrentlyimprove photocatalytic and electrochemical performance, recent research focuses on optimizingsynthesis techniques, doping tactics, and composite formation. As a result, NiO continues to be asustainable and adaptable material that connects energy conversion and storage technologies.

**Keywords:** green approach; photocatalytic activities; antimicrobial activity; cytotoxicity;antioxidant activity; supercapacitor

**OP 09**

# SYNERGISTIC INTEGRATION OF rGO AND PROTONATED g-$C_3N_4$ WITH $CeAlO_3$ PEROVSKITE FORENHANCED ELECTROCHEMICAL AND SUPERCAPACITOR PERFORMANCE

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Supercapacitors are indispensable for contemporary energy storage regarding their incrediblerapid charge and discharge capabilities, high power density, and long cycling life. Perovskites($ABO_3$) are chosen as promising electrode material because of their highly flexible crystalstructure, where different cations can occupy the A and B sites. They possess a tunableelectronic structure, mixed ionic-electronic conductivity for efficient charge transfer, andoxygen vacancies that ion diffusion and surface activity. Thus, they exhibit fast surface redoxreactions. This research focuses on the synthesis of $CeAlO_3$ and rGO/$CeAlO_3$/protonated g-$C_3N_4$ fabricated by coprecipitation and sonication method, respectively. $CeAlO_3$ is anexemplary electrode material because it encompasses pros such as the electrochemical activityof Ce and the structural stability of Al. The minimal surface area and moderate conductivityare the limitations of $CeAlO_3$, which can be overcome by the incorporation of composites likerGO, to enhance conductivity, and protonated g-$C_3N_4$, to increase porosity and active sites. Inthat regard, the final hybrid composite material, rGO/$CeAlO_3$/protonated g-$C_3N_4$, results inincreased conductivity, improved active surface area, enhanced specific capacitance, and long-term cyclic stability. Several physical characterizations, such as X-ray diffraction (XRD),Raman, and Scanning Electron Microscopy (SEM), were put forward to investigate theelectrode material's phase purity, structure, and morphology. This study demonstrates therGO/$CeAlO_3$/protonated g-$C_3N_4$ hybrid composite exhibits immense potential and conceivableapplication in next-generation energy storage devices.

**Keywords:** Perovskites, rGO, protonated g- C3N4, Hybrid supercapacitors, Energy storagesystem

**OP 10**

# SYNERGISTIC EFFECTS IN HIGH-ENTROPY NiCoCrFeZn-LDHs FOR BOOSTED OXYGEN EVOLUTION REACTION PERFORMANCE

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Efficient and durable oxygen evolution reaction (OER) electrocatalysts play a pivotal role in enabling sustainable hydrogen production through water electrolysis. Among various candidates, layered double hydroxides (LDHs) have attracted considerable attention owing to their tunable composition and abundant active sites. However, their catalytic performance is often constrained by limited elemental diversity and sluggish charge transport. In this study, we report the rational design and hydrothermal synthesis of high-entropy layered double hydroxides (HE-LDHs) comprising Ni, Co, Cr, Fe, and Zn. The synergistic incorporation of multiple metal cations within a single layered framework enhances structural stability through high configurational entropy and simultaneously optimizes the adsorption energies of OER intermediates.

Structural and morphological analyses confirm the formation of well-defined nanosheet architectures with large surface area and uniform elemental distribution. Electrochemical evaluation in 1 M KOH and 0.33 M urea electrolyte reveals excellent bifunctional activity, exhibiting a low overpotential of 340 mV at 10 mA $cm^{-2}$, accompanied by a Tafel slope of 78 mV $dec^{-1}$ for OER. In addition to OER, the catalyst was further explored for the urea oxidation reaction (UOR) to assess its bifunctional electrocatalytic capability. The HE-LDHs thus demonstrate remarkable catalytic efficiency, stability, and versatility, positioning them as a promising class of multifunctional catalysts for scalable energy conversion and wastewater remediation technologies.

**Keywords:** High entropy layered double hydroxides, Oxygen evolution reaction, Electrocatalysis

**OP 11**

# SUSTAINABLE PREPARATION OF HYDROXYAPATITE FOR BIOCOMPATIBILITY

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The Bioceramic Hydroxyapatite (HAp) is an ideal biomaterial for bone and dental regeneration. The Oyster shells (*Crassostrea virginica)* is a marine biowaste with an estimated global disposal of nearly 10 million tonnes annually. In this present study, the shells were utilized as a green calcium source for HAp preparation via Wet chemical precipitation method. The usage of Oyster shell not only reduces environmental waste but also offers a naturally derived, bioavailable form of calcium carbonate that enhances the osteoconductivity of the resultant HAp. A Comprehensive spectroscopic and morphological characterizations confirmed the successful formation of nanoscale HAp with unique physicochemical features and phase purity. The Hemolysis assay of the prepared material confirmed their excellent biocompatibility, meeting the requirements of the standard. The material exhibited good bioactivity in simulated body fluid (SBF) analysis, as evident from its mineralisation behaviour. Furthermore, protein adsorption studies using haemoglobin as a model showed high adsorption capacity. Overall, the study highlights the sustainable and value-added approach of converting marine biowaste into valuable bioceramics for bone tissue engineering.

**Keywords:** Hydroxyapatite, Oyster shell, Biocompatibility, Bioactivity, Bone tissue engineering.

**OP 12**

# GREEN SYNTHESIS AND CHARACTERISATION OF ZINC OXIDE NANOPARTICLESUSING *MUSA ACUMINATA* '*RED DACCA*' PEEL EXTRACT AND ITS ANTIBACTERIALACTIVITIES

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Nano technology is a science and engineering branch of contemporary well entrenchedtechnology referring at the nanoscale 1 to 100nm. Green eco-friendly approach has been impressivelyexplored for the synthesis of a diverse range of nanostructures during the previous few decades. MusaAcuminata (Red Dacca) peel extract as a capping agent is possible since the peel extract containssecondary metabolite compounds such as flavonoids, polyphenols, alkaloids and saponins. Zinc oxidenanoparticles (ZnO NPs) have been successfully prepared using Musa Acuminata peel extract. Thestructural and compositional properties of the NPs were systematically studied to confirm thesuccessful formation of the particles. The structural characteristics of prepared nano $ZnO_2$ particles isanalysed by using FT-IR Spectroscopy. The surface morphologies were analysed by the ScanningElectron Microscopy method. X-Ray Diffraction (XRD) analysis showed that the prepared NPsexhibit wurtzite structure with an average particle size of 28.5nm. The zinc oxide nanoparticlesexhibited an absorption peak at 371 nm in the UV–Visible spectrum. The EDAX results revealed thatthe sample possessed the expected elemental composition, with zinc (Zn) having an atomic percentageof 34.32% and some other elements such as O, C, Na, S and K originated from the bimolecules ofMusa Acuminata (Red Dacca) peel. The antibacterial activity of synthesized zinc oxide nanoparticlesshows effective zone of inhibition of antibiotic assay against Staphylococcus aureus, E.Coli, Bacillussubtilis, Bacilius cerus by disc diffusion method.

**Keywords:** Musa Acuminata, Zinc oxide Nanoparticles, UV-Visible spectroscopy, Wurtzite, DiscDiffusion method

**OP 13**

# EXPLORING THE ROLE OF π-CONJUGATION ON THE ELECTROCHEMICAL PROPERTIES OF BIMETALLIC MOFs IN SUPERCAPACITOR APPLICATION

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Integration of organic and inorganic materials offers promising options for emerging applications. Currently, metal-organic frameworks (MOFs) are utilized for supercapacitor applications due to their unique physical and chemical properties. Here, we developed a bimetallic NiCo-MOF using terephthalate moieties through a simple solvothermal method, yielding good results. These materials were thoroughly characterized with various spectroscopic and microscopic analyses. The effect of the conjugation system on the electrochemical performance of the prepared materials was investigated. The results show that increased conjugation significantly improves electrochemical performance by enhancing electrolyte penetration and promoting ion diffusion, thus boosting charge storage. In a three-electrode setup, NiCo-NDC showed a better specific capacitance of 532 F/g related to 356 F/g for NiCo-BDC, along with excellent cyclic stability (107% retention over 5000 cycles). Additionally, NiCo-MOFs and activated carbon served as the positive and negative electrodes, respectively, to fabricate an asymmetric coin cell. NiCo-NDC delivered a power density of 340 W/kg, an energy density of 8 Wh/kg, and demonstrated outstanding cyclic stability (128% retention). These results highlight that the conjugation system plays a vital role in increasing surface area, specific capacitance, and long-term stability.

**Keywords:** MOFs, π-Conjugation, Solvothermal, cyclic stability, Asymmetric Supercapacitor.

**OP 14**

# SYNTHESIS AND BIOCOMPATIBILITY ASSESSMENT OF TITANIUM CARBIDE MXENE AS A SMART MATERIAL FOR SUSTAINABLE BIOMEDICAL SOLUTIONS

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This study presents the synthesis and biocompatibility evaluation of Titanium Carbide ($Ti_3C_2T_x$) MXene as a smart material with potential for sustainable biomedical applications. $Ti_3C_2T_x$ MXene was synthesized using a fluorine-free LiF/HCl etching approach, ensuring a safer and more controlled fabrication process. Comprehensive characterization confirmed successful synthesis and structural integrity. UV–Vis spectroscopy revealed distinct absorption peaks at 260 nm and 805 nm, representing the characteristic optical signatures of $Ti_3C_2T_x$ MXene nanosheets, with the latter peak indicating their plasmonic behaviour. The gradual decline in peak intensity over time suggested aqueous degradation, a relevant factor for photothermal and photodynamic therapeutic applications.

Biological assessments indicated promising safety and functional performance. $Ti_3C_2T_x$ MXene exhibited notable antimicrobial activity against *Staphylococcus aureus*, attributed to surface-induced membrane disruption. Cytocompatibility studies on MG-63 osteoblast-like cells demonstrated high cell viability at 10 and 30 µg/mL concentrations, supported by phase-contrast microscopy showing normal cellular morphology. Zebrafish embryo assays further confirmed minimal toxicity, reinforcing the material's biocompatibility.

These findings establish $Ti_3C_2T_x$ MXene as a promising smart material with strong potential for next-generation biomedical technologies, including antimicrobial surfaces, drug delivery systems, and tissue engineering scaffolds.

**OP 15**

# SYNTHESIS AND CHARACTERIZATION OF NOVEL SCHIFF BASE LIGAND DERIVED FROM ORTHO-HYDROXY BENZALDEHYDEAND 2-AMINO-3-PICOLINE AND ITS COORDINATION COMPLEXES: BIOLOGICAL STUDIES

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In the current study, we synthesized a Schiff base ligand by taking equimolar concentrations of ortho-hydroxy benzaldehyde and 2-amino 3-methyl pyridine and expanded it to its metal complex. Thermogravimetric analysis, FTIR spectroscopy, UV-Visible spectrophotometry, and $^{1}H$ NMR results for the synthesised ligand and metal complexes has been obtained and analysed. The study also reveals the antibacterial benefits of the synthesized ligand and metal complexes, which are tested against Bacillus subtilis and Escherichia coli. Additionally, it also proves that by improving membrane penetration, it increases the lipophilicity and the chelation impact. Hence, this study reveals that the tailored metal complexes exhibit a promising antibacterial property. Molecular docking studies has been studied.

**OP 16**

# DEVELOPMENT OF GREEN ANALYTICAL METHOD FOR THE SEPARATION AND QUANTIFICATION OF UV-INACTIVE CIS/TRANS-4-(METHYLAMINO) CYCLOHEXYLMETHANE SULFONIC ACID VIA MULTI-DETECTOR HPLC

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Trans-4-(methylamino)cyclohexane-1-sulfonic acid is a key intermediate widely used in organic synthesis and plays a major role in the pharmaceutical industry. It is significant component used in the synthesis of Oclacitinib, a Janus kinase (JAK) inhibitor used in the treatment of allergic dermatitis in canines, as well as in the synthesis of structurally related therapeutic molecules. The structural purity of this key intermediate is important because of the presence of isomeric impurities, especially the Cis-4-(methylamino)cyclohexane-1-sulfonic acid, can impact both the efficiency and safety of downstream pharmaceutical products. Therefore, developing a reliable and reproducible analytical method for the accurate identification and quantification of this undesired isomer is essential for upholding the product quality and safeguarding the compliance with regulatory standards.The present study emphases on the development of an environmentally sustainable analytical approach for the separation and quantification of the cis-isomer impurity in the trans-isomer matrix. A green high-performance liquid chromatography (HPLC) method was designed using a ZIC-HILIC (zwitterionic hydrophilic interaction liquid chromatography) column, which provides higher selectivity and good resolution for the closely related isomers. The chromatographic conditions were optimized by fine-tuning factors such as mobile phase composition, flow rate, and temperature to achieve high separation efficiency with minimal solvent consumption.

The method achieved a clear baseline separation between the cis and trans isomers and confirmed a limit of detection (LOD) as low as 0.26% for each, highlighting its sensitivity and suitability for trace-level impurity analysis.Comprehensive method validation was accomplished following ICH guidelines to make sure analytical robustness. The validation parameters exhibited excellentlinearity ($R^2 > 0.999$) over the studied concentration range, precision with relative standard deviation (RSD) values below 2%, and satisfactory solution stability, confirming the method's reliability for routine quality control. The adoption of eco-friendly buffers, solvents and minimal waste generation further supports the principles of green analytical chemistry, highlighting the sustainability without compromising analytical performance.Overall, this robust and environmentally benign HPLC method provides a powerful tool for the routine monitoring of isomeric purity in Trans-4-(methylamino)cyclohexane-1-sulfonic acid. It ensures the stable production of high-quality pharmaceutical intermediates and products, improves process reliability, and aligns with the growing industry emphasis on green chemistry and sustainable manufacturing practices in pharmaceutical analysis.

**OP 17**

# SYNTHESIS, GROWTH, CHARACTERISATIONS AND APPLICATIONS OF 3-HYDROXYPYRIDINIUM L-THREONATE SINGLE CRYSTAL

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3-Hydroxypyridinium L-threonate (HPLT), an organic single crystal, was grown at room temperature using the slow evaporation method. SXRD investigation reveal that HPLT belongs to the orthorhombic system with the space group P1. The functional groups are found using FTIR analysis. The UV-Vis spectroscopy, which includes optical absorption, is used to calculate the band gap energy and optical characteristics. The cut-off wavelength is identified as 270nm. The Band gap energy is found to be 3.0eV. As a result, it has semiconductor properties. Photoluminescence investigations were used to access the luminous effect. HPLT's SHG efficiency is 1.4 times than that of standard KDP. The antibacterial and antifungal activities of formed crystals are more effective against species with references. Nonlinear optical behavior was examined by SHG measurements, and the material displayed an efficiency 1.4 times greater than that of potassium dihydrogen phosphate (KDP), validating its suitability for NLO device development. Furthermore, antimicrobial analyses showed enhanced antibacterial and antifungal activity against selected microorganisms. The multifunctional optical and biological characteristics of HPLT suggest that it is a promising material for applications in optoelectronics, photonics, and biomedical industries.

**Keywords:** Slow evaporation, SXRD, functional groups, band gap energy, luminous effect, SHG efficiency

**OP 18**

# PRODUCTION OF BIO-DEGRADABLE CHITOSAN-CITRATE-CELLULOSE FLIMSVIA ECO-FRIENDLY TECHNIQUES FOR FOODS

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The increasing environmental threat from non-biodegradable plastics demands sustainablealternatives for packaging. This study focuses on developing eco-friendly chitosan–citrate–cellulose composite films for active food packaging applications. Chitosan, known for itsbiodegradability and antimicrobial action, was blended with cellulose extracted from Manilatamarind outer coats using alkali and bleaching methods. Citric acid served as a natural crosslinker,creating a polyester network through a catalyst-free melt polycondensation process, supporting agreen synthesis route.The films were characterized by FT-IR, XRD, and SEM. FT-IR confirmed ester bondformation between chitosan, cellulose, and citric acid. SEM revealed a smooth and flexible surface,while XRD indicated a semi-crystalline structure. The composite films showed strong antibacterialactivity against Staphylococcus aureus and Escherichia coli due to the synergistic effects ofchitosan and citric acid. Hydrogen peroxide scavenging assays demonstrated notable antioxidantproperties, suggesting usefulness in preventing oxidative food degradation.Biodegradation tests in phosphate buffer (pH 7.4) showed significant mass loss, confirmingexcellent environmental compatibility. Thus, the developed chitosan–citrate–cellulose filmsexhibit biodegradability, antimicrobial ability, and antioxidant potential, making them promisingcandidates for sustainable active food packaging.

**Keywords:** Biodegradable polymer; Chitosan; Cellulose; Citric acid; Antibacterial activity;Biopolymer; Sustainable packaging.

**OP 19**

# SYNTHESIS OF CE - Sb SURFACE INITIATED EPOXY POLYMER FOR FLAME RETARDANCY VIALIVING RADICAL POLYMERISATION

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Epoxy resins are widely employed in structural composites, coatings, and electronic encapsulants, yet their inherent flammability remains a critical limitation for advanced applications. In this study, a dual-engineered epoxy system was developed by integrating diglycidyl ether of bisphenol A (DGEBA) with poly(glycidyl methacrylate) (PGMA) through surface-initiated living radical polymerization. Cerium (Ce) and antimony (Sb) dopants were introduced during polymerization to exploit their synergistic flame-retardant mechanisms. $CeO_2$ provides radical scavenging via reversible $Ce^{3+}$ /$Ce^{4+}$ redox cycling, while $Sb_2O_3$ promotes condensed-phase char formation, together enabling both gas-phase and condensed-phase protection. The controlled architecture afforded by living radical polymerization ensured uniform grafting density and reproducible incorporation of dopants, overcoming dispersion limitations typical of conventional blending. Structural and thermal analyses confirmed successful hybridization, while cone calorimetry and thermogravimetric evaluation demonstrated significant reductions in peak heat release rate and enhanced char yield. Mechanical testing indicated that the dual-engineered system preserved epoxy toughness while improving interfacial adhesion. This work establishes a new paradigm for designing halogen-free flame-retardant epoxy polymers by combining inorganic redox-active dopants with controlled polymerization strategies, offering scalable potential for high-performance, environmentally responsible materials in safety-critical applications.

**Keywords:** Epoxy resins, SET - LRP, Controlled architecture, High performance, Flameretardant.

**OP 20**

# CIRCULAR THINKING OF WASTE TO SUSTAINABLE PRODUCTS: HUMIC ACID ADSORPTION ONTO ZnS NANOPARTICLES LOADED BIOMASS AND CONVERSION INTO NUTRIENT RICH ALGINATE BEADS FOR AGRICULTURE APPLICATIONS

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This study aims at the adsorption of Humic acid onto ZnS nanoparticles loaded acid activated biomass (ZnS-AAB) and conversion to alginate beads with addition of $K^+$ and $NO_3^{2-}$ for application in agriculture. The ZnS nanoparticles were synthesized using *Manilkara Zapota*seed extract and was found to be less than 2 nm with a band gap of 3.16 eV. The successful incorporation of ZnS onto biomass were evidenced from FTIR, XRD, SEM and EDX techniques. The successful encapsulation of nutrients and ZnS nanoparticles loaded biomass into bead were confirmed with EDX analysis. The adsorption of Humic acid was optimized with Box-Behnken Design and found to be significant with a p-value < 0.0001 and high F-value of 408.25. Error analysis of isotherm and kinetic date validates the applicability of Langmuir and pseudo second order kinetic models with low RMSE and AARE values. The release of nutrients suggests that $K^+$ and $NO_3^{2-}$ release faster and 100% within two weeks compared to Humic acid. The release kinetics of nutrients follow zero order and K-P models which are supported by correlation coefficients and low error values. The structural stability of the beads was confirmed with swelling index study and with FTIR and SEM techniques. The overall results suggest the sustainable and circular approach of the present study with no environmental impacts.

**Keywords:** Alginate beads; ZnS; Biomass; Nutrient release

**OP 21**

# COMPARATIVE STUDY AND FUTURE PERSPECTIVES ON THE UTILIZATION OF RECYCLED CONCRETE AGGREGATE FROM CONSTRUCTION AND DEMOLITION WASTE: PERFORMANCE, SUSTAINABILITY, AND PUBLIC PERCEPTION

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The increasing amount of garbage generated during construction and demolition (C&D) creates potential for sustainable building as well as environmental issues. This trash can be recycled into Recycled Concrete Aggregate (RCA), which offers a workable way to reduce carbon emissions, lessen landfill strain, and conserve natural resources. This study compares RCA from sources related to building and demolition, assessing their effectiveness, advantages for sustainability, and social acceptability.The comparison takes into account important aspects like strength, physical characteristics, and appropriateness for both structural and non-structural uses. Compared to RCA from building debris, RCA from demolition trash frequently contains more attached mortar and contaminants, which somewhat reduces strength. However, both kinds can satisfy modern construction standards if they are handled correctly. Road bases, paving blocks, and low-carbon concrete mixes are examples of creative uses that highlight RCA's adaptability.The public's opinion of recycled materials is a significant topic covered in this study. Public confidence and adoption can be greatly increased by increasing awareness, enhancing quality control, and highlighting successful projects.In the future, community involvement, supportive policies, and technological innovation will be necessary for the widespread use of RCA. Overall, this study shows that RCA provides a low-carbon, sustainable construction pathway that supports resilient urban development and circular economy concepts when it is handled efficiently and approved by stakeholders. For recycled materials to be widely used in infrastructure projects in the future, it is imperative to integrate technical performance with public perception.

**OP 22**

# PHOTOCATALYTIC PERFORMANCE OF $CeO_2$ NANOPARTICLES VIA GELATIN - SODIUM ALGINATE DOPING (GSA - $CeO_2$) FOR THE DECOMPOSITION OF BASIC YELLOW 28 AND BASIC BLUE 41 POLLUTANTS IN INDUSTRIAL WASTEWATER

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The release of chemical dyes into aquatic ecosystems presents significant dangers to the environment owing to their poisonous and persistent characteristics. The current research investigates the augmentation of photo catalytic activities of cerium dioxide ($CeO_2$) nanoparticles through doping with Gelatin Sodium Alginate (GSA) in order to improve their efficiency in degradation aqueous solutions of basic yellow 28 and basic blue 41 dyes. Different quantities of $CeO_2$ nanoparticles were synthesised using a hydrothermal technique and subsequent doped with Gelatin Sodium Alginate (GSA) in order to generate nanoparticles. The SEM pictures verified the existence of spherical formations in all samples. The X-ray diffraction (XRD) spectra reveal lattice deformation resulting from a substitution defect. Photocatalytic tests demonstrated that Gelatin Sodium Alginate (GSA) doped $CeO_2$ nanoparticles displayed markedly improved degrading efficacy. The impact of several parameters on photocatalytic efficiency, including dye solution pH, initial dye concentration, catalyst dosages, and electrolyte effects, was also examined. The mechanism of this research demonstrates that per oxygen radicals have a role in pivotal part in the photocatalytic method. These results collectively affirm that the strategic integration of Gelatin Sodium Alginate (GSA) into $CeO_2$ nanoparticles boosts their photocatalytic effectiveness and customises their function for BY28 and BB41 dyes via radical-driven mechanisms.

**Keywords:**Gelatin sodium alginate doped Cerium Oxide, Radical scavenging, Surface defects, Photocatalytic kinetics.

**OP 23**

# MICRONUTRIENT BASED ALGINATE BEADS FOR AGRICULTURAL APPLICATIONS

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Plant nutrients needed in micro levels are called as micronutrients mineral elements comprising of zinc (Zn) copper (Cu) manganese (Mn) Iron (Fe) Boron (B) molybdenum (Mo) are the essential micronutrients needs for plant growth and development. In this study sodium alginate dissolves in water to from a viscous clear solution, when reacted with Zn, Copper, Ferrie, Nickel salts to form (Zn, Cu, Fe, Ni) agnate beads. In this study all thesefour types of alginate beads used a micronutrient in agriculture applications. Theses alginate beads (Ca-Al, Zn-Al. Fe-Al, Ni-Al) dissolved in water to make it as spray to root of the plants, then to be examine the plant growth and development. The physical structure of the alginate beads is characterized by SEM and FTIR. The morphology of the alginate beads is observed by SEM and the chemical composition is observed by SEM; the chemical composition is observed by EDAX and FTIR on the of basis of these promising results micronutrients present in alginate beads uses agriculture application.

**Keywords:** Sodium Alginate, Specification alginate bends agriculture application

**OP 24**

# ANALYTICAL APPROACH FOR SEGREGATION OF MULTIFARIOUS AND BLENDED RESIDUAL SOLVENTS IN ZCO1 BY GAS CHROMATOGRAPHIC TECHNIQUE

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The residual solvents analysis is a crucial analysis in the finished products of pharmaceutical API products to determine the ppm level of process solvents used in that products to verify whether it is within the stipulated ppm limit of ICH guideline values or any other monographs to further proceed. My research study focuses on segregation of 10 residual solvents in a single method by gas chromatographic technique without knitting one another and validate it further for regular analysis purpose in ZCO1 compound. The nine residual solvents which I have worked for separation are 2-Propanol, Acetone, Tertiary Butyl amine, Dichloromethane, 3-Pentanone, Triethylamine, Diallylamine, Toluene and n-Heptane in DB-624 column.

**Keywords:** DB-624 column, 2-Propanol, Acetone, Tertiary Butyl amine, Dichloromethane, 3-Pentanone, Triethylamine, Diallylamine, Toluene, n-Heptane

**OP 25**

# UTILIZATION OF GGBS IN SMART DYNAMIC CONCRETE TO CONSTRUCT SUSTAINABLE WITH LOW CARBON CEMENTITIOUS CONTENT WITH FEA SOFTWARE

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This study evaluates the combination of Ground Granulated Blast Furnace Slag (GGBS) into smart dynamic concrete formulations gives a sustainable pathway to decreasing the carbon footprint associated with traditional cementitious substances. GGBS, of the metallic company, serves as a supplementary cementitious fabric, enhancing each the mechanical and durability residences of concrete while contributing to environmental conservation. This takes a look at explores the synergistic results of incorporating GGBS into dynamic concrete mixes, that specialize in its effect on workability, strength development, and prolonged-time period durability. through in element converting regular Portland Cement (OPC) with GGBS, the concrete superior resistance to chloride ingress, sulphate attacks, and alkali-silica reactions, thereby extending the service existence of structures. additionally, the reduced warmness of hydration related to GGBS minimizes thermal cracking in mass concrete packages. To optimize the general overall performance of GGBS- mixed concrete, Finite detail evaluation (FEA) software application is employed to simulate and analyses structural conduct beneath sever loading conditions. FEA equipment facilitates the assessment of strain distribution, deformation patterns, and failure mechanisms, permitting the layout of concrete systems that meet specific typical overall performance standards while adhering to sustainability goal. In M40 concrete, replacing 50% of OPC with GGBS slightly reduces early strength but achieves comparable 28-day strength.

**OP 26**

# ECO-FRIENDLY DETECTION OF HEAVY METAL IONS – PHYTOCHEMICAL BASED SENSORFROM LEAF EXTRACT OF NYCTANTHES ARBOR-TRISTIS

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This study investigates the potential of *Nyctanthes arbor-tristis* aqueous leaf extractas a natural sensor for detecting metal ions, particularly Copper (Cu), Lead (Pb), and Nickel(Ni). The extract, rich in polyphenolic compounds like flavonoids and coumarins, wasevaluated for its ability to interact with these metal ions, leading to changes in its opticalproperties. When Copper and Lead ions bind to the polyphenolic compounds in the extract,an increase in absorbance intensity was observed, indicating the formation of stable metal-ligand complexes. In contrast, Nickel binding resulted in a reduction in absorbance, possiblydue to quenching effects or changes in the electronic structure of the polyphenol-metalcomplex. These findings highlight the potential of *Nyctanthesarbor-tristis* as a cost-effectiveand environmentally friendly biosensor for monitoring metal ion contamination, With thecapacity to provide selective and measurable responses for Copper, Lead, and Nickel inaqueous environments.

**Keywords:** *Nyctanthes arbor-tristis*, Sensor, Polyphenols, Metal ions, Adsorption,Absorbance

**OP 27**

# FUNCTIONALIZED POLYMER ELECTROLYTES FOR SUSTAINABLEDIRECT METHANOL FUEL CELL PERFORMANCED

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The energy potential of hydrogen should be promoted to develop new and environmentallyfriendly solutions for future energy demands, enabling a smooth transition from fossil fuels.Although hydrogen has high potential to replace conventional fuels, it can significantlycontribute to achieving sustainable green energy in the future economy. In this work, directmethanol fuel cells (DMFCs) offer appreciable high-energy density with low emissions by usingmethanol as the fuel and relying on the performance of the polymer electrolyte membrane(PEM). The key component, PEM, must provide high proton mobility while addressingchallenges such as dimensional stability, high-temperature operation, methanol crossover,durability, and high cost. The present work focuses on developing functionalized polyether imide(PEI) based composites by incorporating a metal organic framework (MOF) as inorganic filler inthe polymer matrix. The objective is to improve essential PEM properties, including ion-exchange capacity, water uptake, mechanical strength, thermal stability, and proton conductivity.Uniform dispersion of MOF in the sulfonated matrix was confirmed using XRD and FT-IRanalyses, along with morphological studies. The prepared composite membranes exhibitedenhanced ion-exchange capacity and proton conductivity compared to both the sulfonated andpristine polymers. The developed membranes are suitable PEM candidate for DMFCapplications.

**Keywords:** Sustainable energy, Direct methanol fuel cells, Metal organic framework, Polyetherimide, Proton exchange membrane.

**OP 28**

# SYNTHESIS OF FERROFLUIDS FROM $ZnFe_2O_4$ NANOPARTICLES AND DEEP EUTECTIC SOLVENTS (DES) FOR PHOTOCATALYTIC APPLICATION

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The precursors used for synthesis of ferrofluids are nano sized Zinc ferrite ($ZnFe_2O_4$) particles and Deep Eutectic Solvents (DES). The structural and morphological characteristics for $ZnFe_2O_4$ nanomaterials were studied using Powder X-ray diffraction (PXRD), Fourier Transform Infrared Spectroscopy (FT-IR) and Scanning Electron Microscopic (SEM) studies. The ferrofluids was prepared using Deep Eutectic Solvent (DES) as a carrier liquid. Lactic acid, glycine and water based ferrofluids was successfully synthesized. Homogeneous liquid obtained indicated the formation of eco-friendly DES. The two synthesized precursors were mixed in 1:1 ratio indicating the formation of ferrofluids. The as synthesized ferrofluids (ZFGL) was studied for their application in photo catalysis.

**OP 29**

# PARTICLE PREPARATION AND CHARACTERIZATION OF POLYMORPHIC FORMS AND CO-CRYSTALS OF MESALAMINE WITH EMPHASIS ON SURFACE ENERGY HETEROGENEITY

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Polymorphism plays a crucial role in defining the physicochemical properties and processability of active pharmaceutical ingredients. This study focuses on the preparation and characterization of various polymorphic forms, salts, and co-crystals of mesalamine, emphasizing the relationship between surface energy heterogeneity and solid-state stability, solubility, and interfacial behavior. Controlled crystallization and co-former selection techniques were employed to obtain distinct crystalline forms. The prepared materials were characterized using X-Ray Diffraction (XRD) to confirm phase identity, Differential Scanning Calorimetry (DSC) for thermal analysis, and Fourier Transform Infrared Spectroscopy (FTIR) to study molecular interactions. Advanced surface characterization was carried out using Inverse Gas Chromatography (IGC) and Dynamic Vapor Sorption (DVS) to quantify surface energy parameters such as dispersive surface energy, acid–base (specific) energy, work of cohesion, work of adhesion, and surface polarity. These parameters provided a detailed understanding of the energetic heterogeneity across crystal surfaces and their influence on molecular interactions, moisture affinity, and particle–particle or particle–excipient compatibility. The results demonstrated that variations in polymorphic structure led to distinct surface energy profiles, directly influencing mesalamine's hygroscopicity, solubility, and stability. The study highlights the significance of surface energy mapping as a predictive tool for optimizing formulation design, improving flow behavior, and ensuring long-term stability of mesalamine and similar pharmaceutical solids.

**OP 30**

# DEVELOPMENT AND VALIDATION OF A SUITABLE ANALYTICAL METHOD FOR THE QUANTIFICATION OF TOXIC EPICHLOROHYDRIN AND ELEMENTAL IMPURITIES IN CARVEDILOL PHOSPHATE API

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The presence of toxic impurities in pharmaceutical substances poses a critical challenge to drug safety and therapeutic efficacy. When such impurities exceed permissible thresholds, they can induce severe biological effects, including genotoxic outcomes such as chromosomal aberrations and gene mutations. These toxicological manifestations may further contribute to adverse pharmacological responses and potential carcinogenicity. The detection and quantification of these impurities require highly sensitive analytical methodologies, as regulatory limits are typically at trace levels, complicating their monitoring and control. Therefore, effective impurity management necessitates well-defined specifications and the application ofvalidated analytical techniques to ensure product quality.

In this study, Gas Chromatography–Mass Spectrometry (GC–MS) was employed for the quantification of epichlorohydrin, a toxic impurity, while Inductively Coupled Plasma–Mass Spectrometry (ICP–MS) was used for the determination of elemental impurities such as arsenic, cadmium, lead, mercury, vanadium, cobalt, and nickel in the carvedilol phosphate drug substance. The methods were developed and validated in accordance with pharmaceutical regulatory requirements. The limit for epichlorohydrin in the sample was established as not more than 0.03 ppm, with 10% of the limit of quantification. DB-1701 (30 m × 0.25 mm × 1.0 µm) column was used, with helium as the carrier gas at a constant flow rate of 1.3 mL/min. For elemental analysis, the ICP–MS instrument operated in kinetic energy discrimination (KED) mode, and appropriate limits of detection and quantification were determined.

**OP 31**

# FACILE ONE-POT SYNTHESIS OF POROUSNiCoP@g-$C_3N_4$NANOCOMPOSITE AS ACTIVE PHOTOCATALYST MATERIAL FOR DECOMPOSITION OF DYES LIKE MB AND MO

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The discharge of hazardous dyes and organic pollutants into water ecosystems necessitates the development of efficient and sustainable treatment technologies. Photocatalysis has emerged as a promising strategy for pollutant degradation, yet many traditional catalysts suffer from low efficiency and rapid charge recombination. In this study, a porous NiCoP@g-$C_3$ $N_4$ nanocomposite was successfully synthesized through a hydrothermal method to enhance photocatalytic performance. The obtained photocatalyst was thoroughly characterized using XRD, FTIR, FESEM, HRTEM, UV–Vis spectroscopy, BET isotherm analysis, and XPS to determine its structural, functional, morphological, and chemical features. The results confirmed the effective attachment of NiCoP nanoparticles onto the surface of graphitic carbon nitride (g-$C_3$ $N_4$ ). The photocatalytic activity of the composite was evaluated against the degradation of methylene blue (MB) and methyl orange (MO), followed by optimization studies involving pH, catalyst dosage, and scavengers. NiCoP@g-$C_3$ $N_4$ exhibited significantly enhanced degradation efficiencies of 95% for MB and 84% for MO compared to pure g-$C_3$ $N_4$ . Scavenger experiments revealed that the Z-scheme charge transfer mechanism plays a crucial role in promoting efficient electron–hole separation under UV light. Overall, the findings demonstrate that the synthesized NiCoP@g-$C_3$ $N_4$ nanocomposite is a highly effective photocatalyst, offering strong potential for the removal of organic contaminants from wastewater and other environmental systems.

**Keywords**: NiCoP; g-C3N4; High surface area; Photocatalytic activity; Methylene blue, Methyl

**OP 32**

# POLYPHENOL-BASED SMART ANTIMICROBIAL SYSTEMS: A GREEN PATHWAY TO LOW-CARBON ENVIRONMENTAL MATERIALS

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The global shift toward low-carbon technologies and sustainable environmental solutions has increased the demand for natural bioactive compounds capable of replacing synthetic chemical agents. Polyphenols, widely distributed in plant and marine sources, exhibit strong antioxidant and antimicrobial properties, making them promising candidates for green, smart material development. This study explores the extraction, optimization, and functional evaluation of polyphenols obtained from curry leaves (*Murraya koenigii*), ginger (*Zingiber officinale*), and nori (*Pyropia yezoensis*) to support the creation of sustainable antimicrobial systems aligned with low-carbon environmental goals. Polyphenols were extracted using water and ethanol as solvents from ground and sieved raw materials combined in a standardized 1:1:1 ratio. Total polyphenol content (TPC) was quantified using the Folin–Ciocalteu assay with gallic acid as the standard. Antimicrobial activity was evaluated through the well-diffusion method against *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Escherichia coli*. Response Surface Methodology (RSM) was employed to optimize temperature and incubation time to maximize polyphenol yield and bioactivity.Preliminary results demonstrated that ethanol was the most effective solvent, yielding extracts with strong antimicrobial activity. Ginger-rich ethanolic extracts produced the highest inhibition zone of 16 mm against *Staphylococcus aureus* at 100 µL/well. Water-based extracts showed pronounced activity against *Escherichia coli*, producing a 15 mm inhibition zone. These findings highlight the potential of polyphenol-rich extracts as functional components in smart antimicrobial systems—including bioactive films, surface coatings, and eco-friendly packaging. By utilizing renewable natural resources, this study contributes to the advancement of low-carbon, sustainable materials and offers a green pathway for reducing dependence on synthetic antimicrobial agents.

**OP 33**

# ARTIFICIAL INTELLIGENCE IN THE PHYTOCHEMICAL PROFILING OF EDIBLE FLOWERS: EVALUATION OF NUTRACEUTICAL POTENTIAL

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**Background:** Edible flowers have been valued by many cultures for generations for their vibrant colours and their use in cooking. According to recent studies, these flowers are excellent candidates for use as functional food ingredients since they are high in nutrients and phytochemicals. **Scope and methodology:** This review critically examines literature from 2018 to 2025 to evaluate the nutritional and bioactive potential of edible flowers. Its major focus is the comparisons of traditional analytical methods—such as HPLC, GC-MS, and NMR—with modern AI-supported approaches like machine-learning-based pattern recognition and spectral data mining, assessing how each method performs in identifying compounds and predicting bioactivity.

**Key findings and conclusions:** Common edible flowers are rich in flavonoids, polyphenols, anthocyanins, vitamins, and minerals, but their composition can differ based on genetics, growing conditions, and development stage. Tools driven by AI, such as QSAR modelling and spectral data mining, have simplified the detection of low-level bioactive compounds and helped to clarify how they work. These flowers are now being added to baked goods, drinks, and health products due to their antioxidant, anti-inflammatory, cardiovascular, neuroprotective, and anticancer properties. Typical culinary use shows a very low risk of toxicity or allergic reactions. Looking forward, combining omics technologies with AI-based data integration could help standardize phytochemical profiles, improve clarity in models, and speed up the creation of reliable functional foods and health products.

**Keywords:** Edible flowers, Phytochemicals, Functional foods, AI-supported analysis, Bioactive compounds, Flavonoids, Polyphenols, vitamins, and minerals.

**OP 34**

# SUSTAINABLE MN-MODIFIED MOLASSES-DERIVED CARBON FOAM FOR EFFICIENT REMOVAL OF BISPHENOL-A LEACHED FROM THERMAL RECEIPTS

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This study presents the development and evaluation of a sustainable manganese-modified, molasses-derived carbon foam (Mn-Fmol) for the removal of Bisphenol-A (BPA) leached from thermal receipt papers. Approximately 71.5 mg/L of BPA was estimated to leach from 1 g of thermal receipts, emphasizing the urgency for effective remediation strategies. The Mn-Fmol adsorbent was synthesized using a bio catalysed molasses precursor and characterized through SEM-EDX, TEM, XRD, BET, FTIR, Raman, and XPS to determine its structural and surface properties. Adsorption experiments demonstrated that pH, dosage, and contact time significantly influenced BPA uptake, achieving up to 80% removal under optimized conditions. Statistical Physics Modelling (SPT), applied alongside isotherm and kinetic analyses, provided deeper insight into the adsorption mechanism, revealing monomeric BPA adsorption and endothermic behavior across temperatures ranging from 15–45°C. Spectroscopic results further confirmed the roles of π–π interactions, hydrogen bonding, and hydrophobic forces in enhancing BPA affinity toward Mn-Fmol. Overall, the study underscores the potential of valorising agro-industrial waste into high-performance adsorbents, offering a promising pathway for mitigating environmental risks associated with BPA leaching from thermal receipts. Keywords: Bisphenol-A (BPA); Thermal Receipts; Carbon Foam Adsorbent; Statistical Physics Modelling; Adsorption Mechanism

**OP 35**

# STUDY OF MICROALGAL NANOPARTICLES AND ITS POTENTIAL IN COMBATING ANTIMICROBIAL RESISTANCE

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In recent times the potential of Microalgae for industrial applications has increased exponentially. They are a desirable feedstock for the production of higher-energy density products, biofuels, nutraceuticals, pharmaceuticals, cosmetics, biomaterial, etc. They are reported to be a consistent and reliable supply of secondary metabolites which showcase efficient antibacterial and antioxidant activity as over the years the need for novel antimicrobials is always in demand due to the evolving antimicrobial resistance of pathogens. Nanoparticles are known to be effective in combating bacterial pathogens. But their role in pharmaceutical industry is still evolving because of its toxicity concern. The replacement of conventual nanoparticles with green synthesized nanoparticles has effectively addressed this concern. In the current study, the potential of microalgae from temple ponds is assessed for its antibacterial and antibiofilm activity. In the need to enhance the potential of microalgal metabolites they are combined with silver nanoparticles. UV spectrophotometry, FTIR, XRD, SEM are used for the characterization of the synthesized microalgal silver nanoparticles and antibacterial and antibiofilm assays are performed with both the microalgal extract and the synthesized nanoparticles to analyse their potential for furtherpharmaceutical use.

**Keywords:** Microalgae, silver nanoparticles, antimicrobial resistance, antibiofilm activity, pharmaceutical applications.

**OP 36**

# VARIANT-REINFORCED SURFACE CLADDING ON 3D PRINTED PLA FOR EMI SHIELDING APPLICATIONS

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This project focuses on enhancing both the electrical and surface characteristics of polylactic acid (PLA), a biodegradable and widely used 3D-printing polymer, through the application of engineered surface claddings. PLA, although environmentally friendly and mechanically adequate for many applications, naturally exhibits low electrical conductivity and limited surface functionality. These limitations reduce its usability in areas such as electromagnetic shielding, sensing, or components requiring improved hardness and durability. To address these gaps, the study investigates a composite surface-modification strategy using functional materials deposited on the exterior of PLA substrates. The primary cladding material explored in this work is biochar, a carbon-rich, highly porous product obtained from the thermal decomposition of biomass. Biochar's microstructure contains interconnected pores and graphitic carbon domains, providing moderate electrical conductivity, good dielectric behaviour, and a large surface area. These properties make it an appealing candidate for sustainable, performance-enhancing coatings. In addition to biochar, metallic powders specifically Aluminium and Copper are incorporated into the cladding formulation. These metals are chosen due to their intrinsic high conductivity, ability to improve charge transport pathways across the coated surface, and their relevance in lightweight EMI (Electromagnetic Interference) shielding and signal-attenuation structures. The cladding is applied using a manual hand-layup technique, which offers simplicity, low equipment requirements, and easy scalability. Araldite epoxy resin is selected as the binder due to its strong adhesion, chemical stability, and compatibility with both PLA and the chosen fillers. The resin-filler mixture is uniformly spread over the PLA specimens, forming a bonded surface layer that integrates the conductive particles within a mechanically stable matrix. Once fabricated, the composite-coated PLA samples are subjected to a series of characterization tests.

Dielectric property measurements are performed to evaluate changes in permittivity, conductivity, and polarization behaviour introduced by the cladding materials. EMI shielding effectiveness is assessed to determine the extent to which the composite layers can attenuate or block electromagnetic radiation, an essential property for components used in electronic enclosures. Surface hardness tests are also conducted to identify improvements in wear resistance and mechanical integrity contributed by the metallic powders and the robust epoxy matrix. Overall, this research presents a sustainable and scalable material-design approach that enhances the functional performance of PLA without compromising its eco-friendly nature.

**Keywords:** Polylactic Acid (PLA), Biochar Cladding, Aluminium Cladding, Copper Cladding, Epoxy-Based Surface Modification, Dielectric Property Analysis, EMI Shielding Effectiveness, Surface Hardness Improvement, Sustainable Composite Materials

**OP 37**

# AN EXPERIMENTAL STUDY ON INORGANIC PCM-BASED COLD THERMAL STORAGE FOR SUSTAINABLE ENVIRONMENTAL TECHNOLOGIES

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A phase-changing material is being studied to find freezing and thawing points for Cold thermal energy storage (CTES). Using inorganic hydrated salts, a type of PCM that can be used in cold energy storage systems without using existing renewable energy systems, prolongs the cooling effect and saves energy. Thermal energy can be stored in hydrated salts due to their high volumetric storage density and relatively high thermal conductivity. Inorganic mixtures can be used either as pure inorganic mixtures or as eutectic mixtures formed by using inorganic-inorganic salts or mixing two or more inorganic salts together. Enhanced thermal energy storage systems can be developed by the use of hydrated salts, whether their compounds are able to function on their own or as a result of eutectic mixtures. It involves the study of eutectic mixtures, which are: 2% $KNO_3$+ 2% $ZnSO_4$+ 96% $H_2O$, 2% $NaHCO_3$+ 2% $CuSO_4$+ 96% $H_2O$, 2% $CuSO_4$+2% $ZnSO_4$+96% $H_2O$. The cold thermal energy system was developed by examining three different novel eutectic mixtures. Having 2% KNO3+ 2% ZnSO4+ 96% H2O as a phase change solution may provide stable phase change behavior and moderate temperature changes, thereby providing greater performance and flexibility.

**Keywords:** Cold thermal storage, latent heat, Eutectic mixture, Inorganic Salts, Phase change materials

**OP 38**

# ANALYTICAL TECHNIQUE FOR QUANTIFICATION OF MONOMETHYL SULFONATE CONTENT IN MONTELUKAST SODIUM BY GAS CHROMATOGRAPHIC TECHNIQUE

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Mono methyl sulfonate is a genotoxic solvent significantly used during the synthesis of Montelukast sodium compound and other various chemical reactions to obtain the desired output. This research study focusses on the determination of Monomethyl sulfonate content in Montelukast sodium compound as process solvent by Gas chromatographic technique in DB-1 Column. The Purpose of this research work is to develop a method to separately determine Monomethyl sulfonate content in the sample and validate it as per ICH guideline values and to furnish a method which within the permissible solvent ppm limit of Monomethyl sulfonate specified in ICH guidelines.

**Keywords:** Monomethyl sulfonate, Montelukast sodium, Gas chromatography, ICH guideline for solvents.

**OP 39**

# SYNTHESIS AND CHARACTERIZATION OF COPPER DOPED COBALT OXIDE AND ITS PHOTOCATALYTIC ACTIVITY AGAINST EOSIN YELLOW AND FUCHSIN BASIC DYES

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This study investigates copper doped cobalt oxide as a catalyst for the significant reduction of Eosin yellow(anionic) and Fuchsin basic dyes (CationSic). The synthesized Cu-doped $Co_3O_4$ NPs have been characterized through XRD, FT-IR, UV-Visible, SEM.TEM, BET, and XPS analyses in various concentrations (2, 4, and 6%) of copper at an ideal temperature of 390 ◦C. The face centered cubic structure of the prepared nanoparticle is found out by XRD analysis. The functional groups present in the nanoparticle is confirmed by FT-IR studies. The random agglomeration of copper nanoparticles on the surface of cobalt oxide is established through morphological research. The band gap value of 6% doped nanoparticles, as demonstrated by UV measurements, is around 2.65eV. The efficiency of photo synthesised materials was evaluated by the degradation of Eosin yellow (anionic) and Fuchsin basic (cationic) dyes in aqueous solutions. Furthermore, the operational parameters were optimised, consisting of the effects of pH, catalyst doses, concentration, and scavenger studies. The results indicated that copper (6%) doped cobalt oxide surpassed other doped and pure cobalt oxide materials. The reusability tests demonstrated its maximum efficiency even after three cycles. The photocatalytic method effectively demonstrated the generation of electron-hole pairs under UV light. The results indicate that the synthesised $Cu@Co_3O_4$ will be significantly beneficial for the degradation of organic contaminants in many sectors.

**Keywords:** Cu @ $Co_3O_4$, Eosin Yellow, Fuchsin Basic, Photocatalyst.

**OP 40**

# PHOTOCATALYTIC DEGRADATION OF RIFAMPICIN BY $ZnBiMoO_2$: A PROMISING SOLUTION FOR ANTIBIOTIC POLLUTION ABSTRACT

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The persistence of antibiotics such as rifampicin in aquatic environments has become a pressing environmental concern due to their incomplete removal in conventional wastewater treatment systems. This study explores the synthesis and application of $ZnBiMoO_4$ nanomaterials as efficient photocatalysts for the degradation of rifampicin. $ZnBiMoO_4$ was synthesized using multiple methods, including hydrothermal, sol-gel, co-precipitation, sonochemical, and microwave-assisted techniques, to optimize structural and morphological properties. The resulting nanomaterials were characterized using XRD, FTIR, UV–Vis spectroscopy, SEM, and TEM, confirming their crystalline nature, high surface area, and visible-light responsiveness. Photocatalytic experiments demonstrated significant degradation efficiency under UV–visible irradiation, with hydroxyl (•OH) and superoxide ($\bullet O_2^-$) radicals identified as the primary reactive species driving the process. The $ZnBiMoO_4$ photocatalyst exhibited stability and reusability across multiple cycles, underscoring its potential for sustainable water treatment. This work highlights $ZnBiMoO_4$ as a promising, eco-friendly material for mitigating pharmaceutical pollution and advancing nanotechnology-driven environmental remediation strategies.

**Keywords:** $ZnBiMoO_4$ , XRD, FTIR, UV–Vis

**OP 41**

# TRANSITION METAL FERRITES: EMERGING CATALYSTS FOR AZO DYE DEGRADATION AND ENVIRONMENTAL REMEDIATION

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Azo dyes represent one of the largest and most persistent classes of synthetic colorants discharged from textile, leather, and printing industries. Their complex aromatic structures and –N=N– azo linkages confer high chemical stability and resistance to biodegradation, making them major environmental pollutants with potential mutagenic and carcinogenic effects. In this context, the development of efficient, low-cost, and reusable catalysts for azo dye degradation has gained significant attention. Transition metal ferrites ($MFe_2O_4$, where M = Mn, Zn, Ni, Cu, or Co) have emerged as promising nanomaterials due to their unique physicochemical properties such as narrow band gap energy, high surface area, chemical stability, and intrinsic magnetic separability. These features enable their efficient use in heterogeneous photocatalysis, photo-Fenton, and Sono-catalytic processes under visible light irradiation.

This work focuses on the synthesis, structural properties, and catalytic performance of transition metal ferrites for the degradation of representative azo dye. The synergistic effects of ferrite composites with conductive or biopolymer supports such as polyaniline, chitosan are highlighted for their enhanced charge separation and degradation rate.Furthermore, the influence of parameters such as pH, catalyst dosage, irradiation time, and dye concentration on degradation kinetics is summarized.

The review concludes with the identification of knowledge gaps and future directions, including the integration of ferrite-based catalysts into hybrid photoelectrochemical systems and wastewater treatment prototypes. Overall, transition metal ferrites demonstrate immense potential as efficient, eco-friendly, and recyclable catalysts for the degradation and mineralization of hazardous azo dyes, providing a promising route toward sustainable environmental remediation.

**Keywords:** Transition metal ferrite, Azo dye degradation, Waste water treatment, Environmental remediation, nanomaterials

**OP 42**

# GREEN SYNTHESIS OF NICKEL OXIDE NANOPARTICLES AND NANOCOMPOSITES AND ITS CHARACTERIZATION, PHOTOCATALYTIC DEGRADATION AND ANTIMICROBIAL EVALUATION

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In this study, the researcher has taken NiO nanoparticles which are eco-synthesized by using the green method. Similarly, the MgO nanoparticles are synthesized by using the green way. Then, both of the synthesized nanoparticles are combined by using the sonication method to synthesize the NiO-MgO nanocomposites in varying ratios (Eg.1:1, 1:2 etc.). Thus, the synthesized nanomaterials and the nanocomposites are characterized by using certain techniques such as UV-Vis, FTIR, XRD, BET, SEM-EDX and TEM. Thereafter, they are applied for the antimicrobial activity. The UV-Vis Spectroscopy results into the maximum wavelength and provides the band gap of the synthesized nanomaterials and nanocomposites. The FTIR technique provides the information regarding the various functional groups which are present in the nanoparticles and nanocomposites. The crystalline nature of the nanomaterials and the nanocomposites is verified by the XRD analysis. The SEM analysis highlighted the aggregation of the particles in the synthesized nanomaterials and nanocomposites. The surface area is assessed by the BET analysis. While TEM analysis provides the morphology of the synthesized materials. Finally, the antimicrobial evaluation is done to show the antimicrobial efficiency of the synthesized nanomaterials against the harmful bacteria and fungi.

**Keywords:** NiO nanomaterial, Nanocomposites, Green synthesis, antimicrobial activity.

**OP 43**

# NANO FORMULATION OF PALMITIC ACID -CAPPED SILVER NANOPARTICLES WITH EXPLORATION OFPHOTOCATALYTIC ACTIVITIES

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Palmitic acid-capped silver nanoparticles (P-AgNPs) have also emerged as a new type of functional nanomaterial to be applied in efficient and sustainable water treatment. Colloidal stability, prevention, and control of interaction with contaminants is achieved by their distinctive surface chemistry, which is founded on long-chain fatty acid ligand. Fatty acid capping provides a hydrophobic-hydrophilic equilibrium to the system, which enables increased dispersion in aqueous systems and the absorption of organic pollutants. It has been shown that P- AgNPs can be used in the production of reactive oxygen species when activated by light; the dyes are degraded fast, with the least secondary contamination. They can also be tuned in their size, charged to surfaces, and embedded into the photocatalytic systems and adsorption-based purification. Overall, P-AgNPs are a strong, stable, and proficient nano-formulation of the next generation of water purification technologies, which would enable the population to possess cleaner water resources and make the environment sustainable.

**Keywords:** Palmitic acid, nano-formulation, photocatalysis, dye degradation, water purification.

**OP 44**

# SOL-GEL SYNTHESIZED Ni-DOPED $ZrO_2$ -CARBON COMPOSITES FOR EFFICIENT PHOTOCATALYTIC DYE DEGRADATION

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Nanomaterials with tailored structural and surface properties have emerged as promising candidates for multifunctional applications in environmental and energy sectors. In this study, Ni-doped $ZrO_2$ (Ni-$ZrO_2$ ) nanoparticles and Ni-$ZrO_2$ supported on pistachio nutshell-derived activated carbon (Ni-$ZrO_2$ /PNSAC) were synthesized using the sol-gel method. These nanomaterials were systematically characterized using UV-Vis spectroscopy, X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDS), Fourier-transform infrared spectroscopy (FT-IR), and Brunauer–Emmett–Teller (BET) surface area analysis to investigate their structural, morphological, and surface features. The photocatalytic activity of the synthesized materials was assessed through the degradation of methylene blue dye under light irradiation. The study demonstrates the potential of these materials in dye removal applications, highlighting their combined photocatalytic and adsorptive capabilities for effective wastewater treatment.

**Keywords:** Ni-doped $ZrO_2$ , Activated carbon, Pistachio nutshell, Sol-gel synthesis, photocatalysis.

**OP 45**

# GREEN SYNTHESIS OF STANNOUS CHLORIDE NANOPARTICLES USING *COLEUS AMBOINICUS* EXTRACT FOR ALIZARIN RED DYE DEGRADATION

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The development of sustainable nanomaterials through environmentally benign routes has gained significant momentum as an alternative to conventional chemical synthesis. In this study, stannous chloride nanoparticles ($SnCl_2$ NPs) were fabricated via a green synthesis approach employing the phytochemically rich aqueous extract of *Coleus amboinicus* as a natural reducing and stabilizing agent. The bioactive constituents—primarily phenolics, flavonoids, and terpenoids—facilitated the rapid nucleation and controlled growth of $SnCl_2$ NPs under mild reaction conditions. The synthesized nanoparticles were systematically characterized using UV–Visible spectroscopy, FT-IR, XRD, SEM, to elucidate their optical properties, functional groups, crystalline nature, surface morphology, and size distribution. The obtained $SnCl_2$ NPs exhibited a predominantly nano spherical morphology with good dispersibility and high surface reactivity. Their catalytic efficacy was evaluated through the photocatalytic degradation of Alizarin Red S dye, a persistent anthraquinone textile pollutant. Kinetic studies revealed that the degradation process followed pseudo-first-order kinetics, demonstrating substantial removal efficiency under optimized parameters. The enhanced catalytic performance is attributed to the synergistic interaction between the nanoparticle surface and the phytochemical residues, which promote electron transfer and radical generation. Overall, the findings highlight the potential of *Coleus amboinicus*-mediated $SnCl_2$ nanoparticles as an eco-friendly, cost-effective, and high-performance nano catalyst for wastewater remediation applications.

**Keywords:** Green synthesis, Metal nanoparticles, Reactive oxygen species, Plant extracts. Photocatalytic degradation.

**OP 46**

# MOLECULAR STRUCTURAL PROPERTIES, VIBRATIONAL SPECTRAL CHARACTERISTICS, AND MOLECULAR DOCKING, BIOACTIVITY ANALYSIS OF ETHYLENE Di (*p*-TOLUENESULFONATE)

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The present work focused to calculate the physical properties, the structural characterization, vibrational spectral analysis, and biological activity of ethylene di (*p*-toluenesulfonate) are probed. The loss of proton from sulphonate acid group induces resonance in the $SO^{3-}$, which leads to partial double bond nature of all S–O bond lengths. Among these values, the deviation of S8-O9 (1.457 (cal.)/1.442 (exp.)) Å, also S8-O10 (1.458 (cal.) /1.428 (exp.)) Å bonds clearly attest their active participation in hydrogen bond acceptor nature. The average length of the S–O bond is 1.457 Å. The grid centre for co-crystal ligand was modified to reflect the precise location within the binding pocket to ensure accurate docking predictions. Hydrogen bonds play a significant role in the structure of biomolecules, on the basis of hydrogen bonding the ligand-receptor interactions. The results obtained from this study would be useful in both understanding the inhibitory mode of EDT derivative. The computed FT-IR, and FT-Raman spectra correlated with experiments observed data in the solid form greater of bands in lower wavenumber region than the observed data. Therefore, computed wavenumbers are scaled for evaluation in order to increase the consistency of the values obtained. The biological activity of compound is suggested by its high polarizability. The molecule of biological activity correlated through calculated electronic properties. The most effective interaction and stabilization energies are calculated through NBO analysis. The results derived from antifungal activity indicate that the compound demonstrates significant antifungal activity when compared to the standard drug Amphotericin-B.

**Keywords:** ethylene di (*p*-toluenesulfonate),Electronic properties, Molecular docking analysis, Antifungal activity, Anti-inflammatory activity

**OP 47**

# CHARACTERIZATION OF AN ECO-FRIENDLY CLAY-OXIDE NANOCOMPOSITE FOR EFFICIENT DYE (BASIC BLUE 9 & BASIC GREEN 4) REMOVAL FROM WASTEWATER

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Water pollution caused by industrial effluents has become a critical global concern, particularly due to the widespread use of synthetic dyes in textile, paper, food, cosmetic, and leather industries.Conventional wastewater treatment methods biological, chemical, and physical often fail to adequately remove dye molecules due to limitations such as high operational costs, formation of secondary pollutants, or low removal efficiency. Among the available techniques, adsorption stands out as an efficient, economical, and reliable method for dye remediation. However, the use of commercial activated carbon is limited by its high cost and regeneration challenges, prompting the exploration of low-cost, abundant, and high-performance alternative adsorbents. The present study addresses this gap by synthesizing and evaluating a stishovite–$MnO_2$ nanocomposite (SMNC) as a novel, eco-friendly, and efficient adsorbent for the removal of dyes from aqueous solutions. The SMNC was prepared by dispersing and homogenizing stishovite clay and manganese dioxide under controlled conditions, followed by drying, pulverizing, and sieving. Both the raw clay and SMNC were characterized using FT-IR, SEM, TEM, and BET analyses to examine their structural, morphological, and surface properties. Batch adsorption experiments were conducted to investigate the removal efficiencies of stishovite and SMNC for four major classes of dyes: acid (Acid Blue 25, Acid Green 25), basic (Basic Blue 9, Basic Green 4). This study establishes stishovite–$MnO_2$ nanocomposite as a high-performance, low-cost, and environmentally sustainable adsorbent for the effective remediation of dye contaminated wastewater.

**Key Words:** Low-cost, SMNC, Sustainable adsorbent, Acid Blue 25, Acid Green 25

**OP 48**

# NOVEL SITU SYNTHESIS OF COPPER-BARIUM NANOPARTICLES SUPPORTED ON REDUCED GRAPHENE OXIDE AND ITS APPLICATION IN DYE DEGRADATION

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Nanoparticles have expressed significant advances owing to wide range of application in the field of bio-medical, sensors, antimicrobials, catalysts, electronic optical fibers, agricultural, bio-labeling and in other areas. Synthesis and characterization of nanoparticles is an important area of research as selection of size and shape of nanoparticles provide an effect control over may of the physical and chemical properties. In this article describe the preparation and characterization of bimetallic alloy nanoparticles of graphene oxide supported mono metals like Cu, Ba, and a bimetallic likes Cu/Ba nanoparticles catalyst were synthesized. The size and shape of the products were characterized by various techniques such as: Field emission scanning electron microscopy with edax (FESEM-EDAX) x-ray diffraction spectroscopy (XRD), UV spectra analyses and antibacterial activities compared to mono metallic nanoparticles against gram negative pseudomonas and gram-positive bacillus, salmonella. Results proved that the newly developed graphene oxide supported bimetallic nanoparticles catalysts can be more efficient to reductive, oxidative and of environmentally important organic pollutant additionally it is also very good biologically active compound.

**OP 49**

# STUDIES ON THE PROPERTIES OF POLYSTYRENE/POLYNAPTHYLMETHACYLATE BLOCK COPOLYMERS USING A FLUORESCENCE TAGGED INITIATOR

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Novel, fluorescent block copolymers comprising of napthylmethacrylate namely, P(S-*b*-napthylmethacrylate), P(S-*b*-DMAEMA) were successfully synthesized by the atom transfer radical polymerization (ATRP) method, using CuBr as the catalyst and N, N, $N^{1}$, $N^{11}$, $N^{111}$ – Penta methyl diethylene triamine as a complexing agent. The polymers were analysed and structural formation was confirmed by NMR, MASS, TGA, FT-IR, GPC, Fluorescence and scanning electron microscope measurements. The polymerization proceeds in a convenient manner according to controlled radical polymerization which is evident by the kinetics. The kinetics of polymerization generally increases with time which in turn the conversion of the molecular weight also increased linearly. Well controlled soluble fluorescent PS and its related block copolymers were prepared by utilizing the living radical polymerization method. The properties related to the functional moiety, degradation, surface arrangement and fluorophore are deeply studied. Fluorescent P(S-*b*-napthylmethacrylate) were intensively fluorescent with distinguishable emission parameters from the fluorophore and the repeating units of the polymer.

**Keywords:** Atom Transfer Radical polymerization; Fluorescence; Living radical polymerization; Cyclohexyl methacrylate; Dimethylaminoethylmethacrylate; Block copolymerization.

**OP 50**

# EFFECT OF LAYERING SEQUENCE AND CHEMICAL TREATMENT ON NATURAL FILLER-BASEDPOLYMER COMPOSITES

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Coir pith was subjected to mercerization followed by acid treatment to obtain cellulose microparticles. These processes resulted in the chemical and surface modification of the coir pith. Chemical composition of the product was carried out as per Tappi standards and indicates the reduction in non-cellulosic material to a great extent. This has been further supported by Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), Optical microscope. Thermograms of the samples showed an improved thermal stability for the treated pith. And treated coir pith was reinforced in epoxy matrix and studied its mechanical and thermal properties.

**Keywords:** Cellulose, Coir pith, Sodium hydroxide treatment, Stearic acid treatment, FTIR, XRD.

**OP 51**

# PEPTIDE-NANO ARCHITECTONICS: PROGRAMMABLE PEPTIDE NANOSTRUCTURES FOR NEXT-GEN DRUG DELIVERY AND TISSUE ENGINEERING

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Peptide-based nanostructures are recognized as a very versatile group of biomaterials because of their nature to be compatible with living organisms, the precision of their structures and the capability of self-assembling into very clear nanoarchitectures. This study is aimed at examining the design of engineered peptide nanostructures for drug delivery and tissue regeneration targeting as well as their properties and relevance in the medical field. Through a stepwise modification of peptide sequences along with the addition of bioactive motifs, we have created a range of nanoscale assemblies including nanofibers, nanotubes, nanogels, and hybrid peptide–polymer composites with tunable mechanical stiffness, controlled degradation profiles, and increased structural stability. Furthermore, the results of the experimental tests show that the nanostructures are effective in various applications including cancer therapy, anti-inflammatory treatment, the control of microorganisms, and gene transfer. This wide range of therapeutic applications signifies the potential of peptide-based carriers. The addition of functional motifs such as RGD, IKVAV, and BMP-inspired sequences leads to a substantial rise in osteogenic, neurogenic, and dermal healing outcomes thus confirming their appropriateness for regenerative medicine. The uniformity, stability, and safety of the synthesized nanostructures were verified by structural and functional analyses conducted using FTIR spectroscopy, electron microscopy, rheology, and in vitro biocompatibility tests. In conclusion, the research considers peptide-based nanostructures as strong and flexible candidates for the delivery of next-generation therapeutics and regenerative engineering, which means that their use in future clinical trials is very likely.

**OP 52**

# PHYTOCHEMICAL ANALYSIS, ANTIOXIDANT, ANTIMICROBIAL AND DNA DAMAGE ASSAY OF EUPHORBIA HIRTA ON SELECTED VETERINARY PATHOGENS

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This study evaluated the phytochemical composition, antioxidant potential, and antimicrobial activity of aqueous and methanolic extracts of Euphorbia hirta leaves, roots, and stems. Quantitative phytochemical analysis revealed high accumulation of phenolics (48.62 ± 2.14 mg GAE/g), flavonoids (27.45 ± 1.86 mg QE/g), tannins (19.83 ± 1.42 mg TAE/g), saponins (12.34 ± 0.79%), alkaloids (8.72 ± 0.65%), terpenoids (6.51 ± 0.48%), and steroids (4.29 ± 0.33%), indicating strong biochemical diversity. Antioxidant assessment demonstrated potent radical-scavenging efficiency, with DPPH activity showing 76.85 ± 2.57% inhibition ($IC_{50}$ = 42.13 µg/mL) and FRAP value of 311.24 ± 9.86 µmol $Fe^{2+}$ /g, confirming phenolic-driven redox capacity. Antimicrobial assays exhibited pronounced inhibitory zones against veterinary pathogens, including Staphylococcus aureus (19.42 ± 1.26 mm), Escherichia coli (17.13 ± 1.04 mm), Klebsiella pneumoniae (15.86 ± 0.93 mm), and Proteus vulgaris (13.77 ± 0.88 mm), with methanolic extracts showing superior efficacy over aqueous preparations. Salient findings indicate phenolics and flavonoids as the dominant contributors to bioactivity, methanolic extracts outperforming aqueous extracts, leaf tissues holding maximum phytochemical density, and a strong correlation between antioxidant strength and antimicrobial performance. Collectively, these results scientifically validate the ethnomedicinal relevance of E. hirta, highlight its potential as a phytopharmaceutical candidate against oxidative-stress-linked infections, and support sustainable natural-drug discovery in alignment with UN SDG-3: Good Health and Well-Being, promoting affordable and plant-based therapeutic solutions.

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**OP 53**

# REGENERATION OF OSTEOCHONDRAL DEFECT VIA SYNTHESIS OF BILAYER SCAFFOLD WITH TRIPLE DRUG RELEASE: AN INVESTIGATION ON THE COMBINATORIAL EFFECT OF DRUGS IN CHONDROGENEIS, ANGIOGENESIS AND OSTEOGENESIS

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The growing world population is suffering from deterioration of joint functions associated with osteochondral defects. An engineering scaffold construct made up of chitosan (CS) layer loaded with Melatonin (Me) and polycaprolactone (PCL) loaded with Naringin (Na) and Resveratrol (Res) encapsulated albumin nanoparticles was fabricated to evaluate the in-vitro performance of chondrogenesis, osteogenesis and angiogenesis in human bone marrow mesenchymal stem cells. FESEM, FTIR, XRD, drug loading capacity (DLC), Swelling ratio, Porosity measurement was performed to analyze the physiochemical characteristics of the scaffold. Moreover, the ability of the bilayer scaffold to degrade for 100 days and the sustained release profile of triple drugs for 30 days followed by molecular evaluation were also conducted. We hypothesize that Melatonin (Me), Resveratrol (Re) and Naringin (Na) significantly promote chondrogenesis and osteogenesis of the hBMSC individually. While the CAM assay evaluate the angiogenic property of these triple drugs alone and from the scaffold.

**OP 54**

# A BIO-INSPIRED POSTBIOTIC-POLOXAMER HYDROGEL SYSTEM FOR TARGETED DELIVERY AGAINST VAGINAL CANDIDIASIS

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Vulvovaginal candidiasis (VVC) is a persistent and distressing condition affecting women globally, with high recurrence rates and growing resistance to standard antifungal therapies. Traditional oral and topical treatments often fail to provide lasting relief due to poor drug retention and non-specific distribution, leading to frequent relapses and unwanted side effects. Recent research has focused on innovative hydrogel-based drug delivery systems, utilizing both natural and synthetic polymers, sometimes enhanced with nanotechnology. In this study, a postbiotic-poloxamer hydrogel was developed as a bio-inspired delivery system designed to enhance the localized management of vaginal candidiasis. A thermos responsive Poloxamer 407 hydrogel is combined with postbiotics to create a hybrid material that combines the structural advantages of a smart polymer matrix with the inherent antibacterial capability. The hydrogel formulation enables use of Poloxamer 407's temperature-dependent sol-gel transition, which makes liquid application simple and guarantees quick gelation at physiological temperatures. This characteristic allows for the continuous release of postbiotic components by enhancing mucosal adherence and extending residence time in the vaginal environment. In addition to preventing fungal growth, the postbiotic portion offers a biologically produced therapeutic component that supports mucosal health and lowers the recurrence of vaginal candidiasis by assisting in the restoration of the normal vaginal microecology. In order to ensure a reliable and

effective delivery system, material characterisation concentrated on assessing gelation behaviour, rheological stability, release kinetics, and interactions between the polymer network and postbiotic components. These results highlight the importance of postbiotic-loaded hydrogels as new functional materials with substantial applications in women's health and biomedical technologies and offer a solid basis for more translational research.

**Keywords:** Hydrogel; Vaginal candidiasis; Drug delivery; Postbiotic; Women’s health.

**OP 55**

# POLYMETHOXYFLAVONES IN AGING INTERVENTION: OVERCOMING BIOAVAILABILITY, METABOLIC, MICROBIOME, AND CLINICAL DEVELOPMENT BARRIERS

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Polymethoxyflavones (PMFs) are specialized flavonoids abundant in tropical plants such as *Citrus* and *Kaempferia* species. They are emerging as promising geroprotective agents due to their ability to regulate multiple aging-related pathways. Preclinical studies highlight their potential to reduce oxidative stress and inflammaging, activate SIRT1, modulate nutrient-sensing pathways like AMPK/mTOR, and offer organ-specific anti-aging benefits. Despite these findings, their clinical translation remains limited by major research gaps.

A key challenge is the poor understanding of PMF bioavailability and metabolism. Although their methoxylated structure increases stability and lipophilicity, in vivo studies show extensive Phase I metabolism via O-demethylation, yielding hydroxylated metabolites that might be more bioactive than the parent compounds

The gut microbiome further influences PMF metabolism. Anaerobic bacteria mediate O-demethylation, creating variable metabolite profiles that may explain differences in individual responses. Integrating microbiome sequencing with metabolite analysis and using antibiotic interventions could reveal microbial contributions to PMF efficacy.

Moreover, few high-quality human clinical studies exist. Most are short, small, and lack objective biomarkers. Future large-scale, placebo-controlled trials should include validated aging markers such as epigenetic clocks, inflammatory cytokines (IL-6, TNF-α), and SASP factors (e.g., GDF15) to establish efficacy. Mechanistically, PMFs act as senomorphics via NF-κB inhibition, but their senolytic potential remains unclear. Lastly, discovering new PMF-rich tropical plants using metabolomic and computational approaches could identify more potent analogues. Addressing these gaps will advance PMFs toward evidence-based geroprotective applications.

**Key Words:** Polymethoxyflavones, Aging, Flavonoids, PMF.

**OP 56**

# GREEN MANUFACTURING OF PHOENIX DACTYLIFERA SEED EXTRACT–INCORPORATED 3D-PRINTED PROVISIONAL DENTAL RESIN

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The present in vitro study evaluated the color stability and mechanical performance of a 3D printed provisional crown and bridge resin modified with Phoenix dactylifera (P.dactylifera) seed extract. Provisional restorations require materials with high resistance to discoloration and adequate mechanical strength, and natural additives such as P.dactylifera seed extract may improve these properties. A novel 3D-printed resin incorporating P.dactylifera seed extract was formulated, and standardized samples were prepared according to ISO guidelines. Color stability (ΔE) was measured using a spectrophotometer, while flexural strength, compressive strength, and microhardness were assessed using a three-point bending test and Vickers microhardness evaluation. Data were statistically analyzed using one-way ANOVA followed by Tukey's post hoc test. The P.dactylifera seed–modified resin demonstrated significantly lower color change than the unmodified control, along with mechanical properties comparable to or exceeding those of conventional provisional materials. These findings indicate that incorporating P.dactylifera seed extract enhances the color stability of 3D-printed provisional resins while maintaining their mechanical integrity, supporting its potential for improved clinical application.

**OP 57**

# SYNTHESIS, CHARACTERIZATION OF NANO-MATERIALS FOR BIOLOGICAL APPLICATIONS OF NANOMATERIALS: A REVIEW

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Nano-biomaterials represent a rapidly evolving class of materials that merge the unique advantages of nanoscale engineering with biological compatibility. This chapter presents an integrative investigation of the green production, advanced classification, and biomedical uses of nano-biomaterials. Although the green synthesis approach emphasizes the usage of plant extracts, microorganisms, in addition biopolymers as sustainable, non-toxic agents to fabricate nanoparticles with controlled morphology and enhanced functionality. Furthermore, this chapter highlights various synthesis techniques, critically analyzing the impact of limitations such as potential of hydrogen, temperature, and precursor concentration about particle formation. Characterization methods containing transmission electron microscopy (TEM), scanning electron microscopy (SEM), X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), UV–Visible spectroscopy, and dynamic light scattering (DLS) are evaluated through establish the physicochemical and structural attributes of synthesized nanomaterials. However, biomedical applications are explored in detail, with emphasis on drug delivery, antimicrobial activity, wound healing, cancer therapy, biosensing, and tissue engineering. The chapter also addresses current challenges such as cytotoxicity, biodegradability, and regulatory limitations, contribution understanding future growth and opportunities for clinical translation. Hence, the aim of this extensive overview is to act as a resource for academics and professionals involved with the areas of pharmaceutical sciences, biomedical engineering, and nanotechnology.

**Keywords:** Nano-biomaterials; Green synthesis; biomedical applications; Drug delivery; Biocompatibility.

**OP 58**

# SYNTHESIS ZINC OXIDE NANOPARTICLES USING *CYNODON DACTYLON* AND ASSESSMENT OF THEIR BIOLOGICAL ACTIVITY STUDIES

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Green nanotechnology offers an eco-friendly approach for producing functional nanomaterials with diverse biomedical applications. In the present study, zinc oxide nanoparticles (ZnO NPs) were synthesized using the aqueous extract of *Cynodon dactylon*, which served as a natural reducing and stabilizing agent. The formation of ZnO NPs was confirmed by their characteristic optical and structural features obtained from UV–Visible spectroscopy, X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), and electron microscopy analyses. These results indicated the successful fabrication of crystalline, phytochemical-capped ZnO NPs with nanoscale dimensions and stable morphology. The biological potential of the synthesized nanoparticles was evaluated through antimicrobial, antioxidant, and cytotoxicity assessments. The ZnO NPs exhibited notable antimicrobial activity against selected bacterial strains, enhanced radical-scavenging capacity in chemical antioxidant assays, and a dose-dependent cytotoxic effect in preliminary cell-compatibility evaluations. Overall, the study demonstrates that *Cynodon dactylon*-mediated green synthesis is an efficient route for producing bioactive ZnO nanoparticles, highlighting their potential applications in pharmaceutical, biomedical, and environmental fields.

**Keywords:** Cynodon dactylon, ZnO nanoparticles, Photochemical-capped, antimicrobial activity.

**OP 59**

# ECO-FRIENDLY FABRICATION OF ZnO NANOPARTICLES FROM OMANI HENNA LEAVES AND EVALUATION OF ANTIBACTERIAL ACTIVITY

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In this study, zinc oxide (ZnO) nanoparticles with an average size of about 20 nm were successfully synthesized via a green synthesis method using Omani henna (Lawsonia inermis) leaves extract as a natural reducing and stabilizing agent. The nanoparticles were extensively characterized by Fourier-transform infrared spectroscopy (FT-IR), ultraviolet-visible (UV-Vis) spectroscopy, X-ray diffraction (XRD), and Scanning Electron Microscopy (SEM), confirming their crystalline structure, surface morphology, and the presence of functional groups linked to the phytochemicals in the henna extract. The antibacterial efficacy of the ZnO nanoparticles was evaluated against *Escherichia coli* using the agar well diffusion method, exhibiting a significant zone of inhibition measuring 16 mm, indicating strong antibacterial activity. These results demonstrate the potential of eco-friendly synthesized ZnO nanoparticles as effective antibacterial agents for biomedical and environmental applications.

**Keywords:** Zinc oxide, X-ray diffraction analysis, Escherichia Coli and Antibacterial Activity.

**OP 60**

# FABRICATION OF A NOVEL HYBRID ZINC OXIDE/ACTIVATED CARBON (ZnO/AC) NANOCOMPOSITE VIA A GREEN METHOD AND ASSESSMENT OF ITS ANTIOXIDANT AND ANTIMICROBIAL EFFICACY

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Inorganic antimicrobial nano agents have more benefits over commonly used organic drugs owing to their chemical durability, heat resistance, immunity, and prolonged efficacy. The present work effectively produced novel zinc oxide/activated carbon (ZnO/AC) nanocomposites, employing Toddalia asiatica leaves as a source of carbon for the production of activated carbon. The liquid extract of Toddalia asiatica leaf was used as a capping and reducing agent in the production of ZnO. The produced substances were analysed using multiple characterization methods, which involves X-Ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FT-IR), Field Emission Scanning Electron Microscopy (FE-SEM), Energy Dispersive X-ray Spectroscopy (EDX), and Transmission Electron Microscopy (TEM), confirming effective production. XRD revealed a predominant role of the crystalline structure of ZnO nanoparticles compared to the amorphous activated carbon, whereas the FTIR spectrum validated a significant interaction amongst the ZnO nanoparticles and activated carbon. SEM and TEM pictures demonstrated that the synthesized ZnO NPs/AC ranged in nanoscale dimensions from 30 to 70 nm. The antioxidant and antibacterial properties of the synthesized nanocomposites towards gram positive and gram-negative bacteria were examined, and the minimum inhibitory concentration values were compared to those of ascorbic acid, ciprofloxacin, and clotrimazole as standards. The findings obtained demonstrate a significant influence in the antioxidant and antibacterial research. The findings indicate that the newly suggested nanocomposite may serve as an efficient filter for combating oxidative and antimicrobial-related disorders.

**Keywords:** Activated carbon, Antioxidant, Antimicrobial, Nanocomposite, ZnO, Toddalia asiatica.

**OP 61**

# A COMPARATIVE PHYTOCHEMICAL ANALYSIS OF SELECTED PLANT (*SOLANUM NIGRUM* AND *ANNONA SQUAMOSA*) AND ITS ANTIBACTERIAL ACTIVITY

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The ethanolic extract mixture of *Solanum nigrum* and *Annona squamosa* represents a well-known traditional herbal formulation employed in Ayurveda and Siddha medicine for the management of diverse pathological conditions. Various parts of these plants—including the leaves, fruits, and seeds—have been extensively documented for their therapeutic relevance. Traditionally, they are administered for ailments such as peptic ulcer, asthma, influenza, eczema, diarrhoea, periodontal infections, pyrexia, and malaria. In the present investigation, a phytochemical screening was carried out to elucidate the major bioactive constituents within these medicinal species. The analysis revealed the presence of key secondary metabolites such as alkaloids, flavonoids, tannins, saponins, phenolic compounds, and glycosides.

The *aureus*, indicating broad-spectrum antimicrobial efficacy. These findings suggest that the mixture possesses notable pharmacological properties; nevertheless, further systematic studies are warranted to isolate, characterize, and quantify the specific active constituents responsible for the observed bioactivity, and to antibacterial potential of the combined ethanolic extract was assessed using the disc diffusion assay. The extract demonstrated significant inhibitory activity against both *Escherichia coli* and *Staphylococcus* validate their therapeutic applicability through advanced biological and pharmacological evaluations.

**Keywords:** *Solanum nigrum, Annona squamosa,* Phytochemical, Antibacterial activity.

**OP 62**

# SYNTHESIS AND CHARACTERIZATION OF NANOSTRUCTURED CALCIUM CARBONATE FROM EGGSHELLS FOR ENVIRONMENTAL AND BIOMEDICAL APPLICATIONS

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The growing demand for sustainable and eco-friendly materials has led to an increasing interest in utilizing waste products, such as eggshells, as sources of valuable nanomaterials. This study investigates the synthesis and characterization of nanostructured calcium carbonate ($CaCO_3$) derived from eggshells for potential environmental and biomedical applications. Eggshells, primarily composed of calcium carbonate, were subjected to a green synthesis process involving mild chemical treatments to produce nanoparticles with controlled size and morphology. The resulting nanomaterials were characterized using a range of techniques, including scanning electron microscopy (SEM), X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), and dynamic light scattering (DLS), to assess their structural, morphological, and chemical properties.

The synthesized calcium carbonate nanoparticles exhibited uniform particle size distribution and high surface area, making them suitable for a variety of applications. In environmental applications, the nanostructured $CaCO_3$ demonstrated effective adsorption properties for the removal of heavy metals and organic pollutants from aqueous solutions. In biomedical applications, the nanoparticles showed potential as biocompatible drug delivery carriers, with low toxicity and the ability to encapsulate therapeutic agents. This work highlights the value of eggshell-derived nanomaterials as a sustainable resource for advanced materials, offering significant benefits in both environmental remediation and biomedical fields. Additionally, it demonstrates the feasibility of turning waste into functional nanomaterials, contributing to a circular economy and reducing environmental pollution.

**OP 63**

# BIO-DERIVED NANOMATERIALS FOR POST-HARVEST PRESERVATION IN AQUAPONICS INTEGRATED FODDER SYSTEMS

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An aquaponics system is an environmentally sustainable farming technique that integrates aquaculture and hydroponics by creating a closed-loop ecosystem. The aquaponics system is based on the principle that it utilizes the effluent water produced by the fish, which is a valuable source of nutrients for plants. This method eliminates the need for chemical fertilizers and can be implemented in a limited space. Fodderponics is a modern, soil-less farming method used to grow fresh green fodder for livestock in a controlled environment. Soilless systems enable year-round cultivation in various settings, such as rooftops and indoor spaces, overcoming geographical limitations and offering efficient, sustainable food production in areas with limited land availability. This model supports the circular economy by recycling nutrient-rich water from agriculture to grow fodder, which in turn supports local livestock production. It empowers urban entrepreneurs, women-led Self-Help Groups (SHGs), and small-scale dairy and poultry farmers to become self-reliant, resilient, and profitable within a limited space. Despite the fact that aquaponics facilitates rapid and chemical-free fodder production, a significant drawback is the limited shelf life of the harvested fodder, which hinders its storage, transportation, and large-scale application. To address this challenge, an organic nanocoating is applied to the harvested fodder using safe, biodegradable, plant-derived nanomaterials, which are intended to enhance moisture resistance, minimize microbial spoilage, and prolong shelf life without compromising nutritional quality. This integrated approach seeks to develop a cost-effective and efficient model for fodder production and preservation that mitigates feed losses, reduces input costs, supports farmers, and promotes sustainability in both urban and rural environments.

**OP 64**

# AI-DRIVEN DISCOVERY OF PLANT-BASED ANTIFUNGAL AGENTS FROM *CESTRUM NOCTURNUM* FOR SUSTAINABLE CROP PROTECTION

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Fungal infections are a major threat to global food production, causing heavy yield losses and increasing farmers' dependence on synthetic fungicides. However, the rising concerns about chemical residues, resistance development, and environmental harm have intensified the search for safer, plant-based solutions. In this context, the present study explores the antifungal potential of crude phytochemicals extracted from *Cestrum nocturnum* leaves, using a comprehensive pipeline that integrates digital prediction tools with laboratory and field evaluations. Leaf samples were subjected to sequential solvent extraction, and the resulting crude extracts were screened for their phytochemical composition. The identified bioactive compounds were further analyzed through molecular docking, ADMET prediction, QSAR modeling, and deep learning approaches to determine their interaction with major fungal protein targets. Based on these computational results, the most promising candidates were evaluated through in-vitro antifungal assays against important plant pathogens, including *Fusarium*, *Alternaria*, and *Colletotrichum* species. Extracts that showed strong inhibitory activity were advanced to greenhouse experiments and field trials to assess their real-world effectiveness. Parameters such as disease suppression, impact on plant growth, and possible phytotoxic effects were carefully monitored. The combined evidence from computational, laboratory, and field studies aims to pinpoint potent plant-derived antifungal molecules and validate their practical utility. Overall, the study contributes to the development of eco-friendly fungicidal alternatives and proposes an efficient screening strategy that can support sustainable crop protection and strengthen food security.

**OP 65**

# CHROMATOGRAPHY AND IN SILICO ANALYSIS REVEAL BURN HEALING POTENTIALS OF MUSA LEAF EXTRACT

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Burn injuries remain a major global public health concern, accounting for approximately 300,000 deaths annually, with the majority occurring in low- and middle-income countries. Beyond the high mortality rate, burn survivors often face substantial physical, psychological, and financial burdens, posing a significant challenge to global healthcare systems. The present study aimed to evaluate bioactive phytocompounds from Musa spp. (banana) leaf extract for their potential role in burn wound healing using a combination of chromatographic and in silico approaches. The obtained extracts were fractionated using column chromatography and subsequently analyzed through Gas Chromatography–Mass Spectrometry (GC–MS) to identify constituent compounds. Molecular docking studies were performed to assess the binding affinity of identified phytocompounds with the target protein Sestrin 2, a key regulator in oxidative stress response and tissue repair. The three-dimensional structures of both target and ligands were retrieved from UniProt, PDB, and PubChem databases, respectively, while PyRx and Discovery Studio software were employed for docking and visualization. Among the identified compounds, Acetamide, 2-(adamantan-1-yl)-N-(1-adamantan-1-ylethyl)- (−8.2 kcal/mol), 3-Quinolinecarboxylic acid, 6,8-difluoro-4-hydroxy-, ethyl ester (−7.3 kcal/mol), and 1H-Isoindole-1,3(2H)-dione, 2-butyl-4,5,6,7-tetrahydro- (−7.2 kcal/mol) demonstrated strong binding affinities compared to the reference drug Silver Sulfadiazine (−6.9 kcal/mol). ADMET analysis further confirmed the low toxicity and favorable pharmacokinetic profiles of these compounds. Therefore, the results suggest that specific banana leaf–derived phytocompounds exhibit promising potential as natural therapeutic agents for burn wound healing.

**OP 66**

# ACTIVATING $MnO_2$ REDOX CENTERS THROUGH Ce-DOPING AND NS-rGO SYNERGY FOR ULTRA STABLE HYBRID SUPERCAPACITOR ELECTRODES

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The global pivot towards sustainable energy infrastructure urgently demands advanced electrochemical energy storage solutions that bridge the gap between the high power of supercapacitors (SCs) and the high energy of batteries. This study introduces a novel, high-performance electrode material, a ternary nanocomposite of Cerium doped α-MnO2 (OMS-2) nanorods integrated with N,S co-doped reduced graphene oxide (NS-RGO) conductive matrix. This architecture is designed to overcome the critical limitations of α-MnO2, specifically its poor conductivity and structural instability. Our approach employs a cost-effective and scalable reflux-based precipitation method, demonstrating a viable path beyond conventional, less scalable techniques. The optimized composite leverages a powerful synergistic effect, with Ce-doping maximizing the concentration of active Ce3+/Ce4+ redox centres and creates beneficial oxygen vacancies, enhancing pseudocapacitive kinetics. Concurrently, the NS-RGO matrix provides a highly conductive, anti-restacking scaffold, facilitating rapid ion transport through increased interplanar spacing. Electrochemical analysis of the optimally configured CeOMS-2/NS-RGO composite, particularly in the H2SO4 electrolyte, showcased transformative performance. The electrode achieved an outstanding maximum energy density of 65 W.h.kg-1 at a high-power density of 104 W/Kg-1, confirming its superior rate capability. Crucially, it exhibited exceptional long-term stability, maintaining 101.6% of its initial capacity after 8000 charge/discharge cycles. This research successfully validates a rational design principle for next-generation hybrid supercapacitor electrodes by intelligently coupling doped metal oxide with heteroatom-functionalized carbon supports, offering a significant advancement in electrochemical energy storage technology.

**OP67**

# pH-MEDIATED CARBON DOT PHOSPHOR FOR DIRECT WHITE EMISSION IN WHITELED SYSTEMS

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Carbon dots (CDs) are nanoscale carbon-rich materials widely recognized for their remarkable photoluminescent behaviour, which arises from quantum confinement and associated surface state effects. Although rare-earth-doped phosphors can generate high-quality white light, their complex preparation and high production costs present significant limitations for large-scale implementation. In this work, we report a reproducible one-step hydrothermal method for producing white-light-emitting CDs, utilizing amino acids as precursors under pH-regulated reaction conditions. The as-synthesized CDs exhibit a broad photoluminescence spectrum with peak emission near 450 nm. To establish a stable colour-conversion phosphor layer and mitigate aggregation-induced self-quenching, the CDs were homogeneously embedded into a suitable polymer matrix. This composite film was subsequently integrated onto a 365 nm UV LED chip and demonstrated long-term stability, maintaining optical integrity for up to 300 days under ambient conditions. Additionally, the CDs exhibited fluorescence lifetime of 18.6 ns, further confirming their stable emissive nature. Notably, the fabricated LED device achieved a high Colour Rendering Index of 86% and produced cool-white illumination characterized by CIE chromaticity coordinates of (0.302, 0.318) and Correlated Colour Temperature of 7236 K, with the emission point close to the Planckian locus. These white CDs derived from amino acids represent a promising class of metal-free phosphor materials for advancing next-generation, cost-effective optoelectronic applications.

**Keywords:** Carbon dots, White light emission, Hydrothermal synthesis, Phosphor-converted LEDs, Photoluminescence properties, Amino acid precursors

**OP 68**

# EFFICIENT HYBRID MATERIALS FOR ENERGY AND ENVIRONMENTAL APPLICATIONS

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Energy and environmental problems are major challenges for the scientists and researchers across the world. Due to increasing demands of the energy with increased population, it has become the major challenge to provide the sustainable solution for the energy and environmental problems of the society. Therefore, the discovery of novel technologies and scientific innovations for renewable energy production is an urgent need. In this connection the development of novel hybrid materials consisting of 0D, 1D and 2D nanomaterials including $TiO_2$ nanorods, nanobelts based composites and g-$C_3N_4$ nanosheets based hybrid nanocomposite materials through photocatalysis process have become emerging technologies to produce renewable hydrogen ($H_2$) and photocatalytic degradation of organic dyes. Since the photocatalytic process undergo at ambient conditions and utilizes renewable sources like water and solar light in presence of small amount of photocatalyst, it is treated as sustainable approach. Moreover, the 1D and 2D composite materials have several advantageous features compared to bulk materials and single nanomaterials as well. These composite nanomaterials can effectively tackle the major challenges of the photocatalytic process viz., (i) the fast recombination of charge carriers, (ii) effective utilization of photo excited electrons for reduction reactions and (iii) surface interface charge transport properties. Therefore, in this talk I will discuss the advantageous features of the 1D $TiO_2$ nanobelts, $TiO_2/Cu_xO$ nanorod arrays,g-$C_3N_4/ZnIn_2S_4$@$Ni(OH)_2$, B-g-$C_3N_4/CdIn_2S_4$nanocomposite photocatalysts for energy and environmental application. Advantageous features of 1D $TiO_2$ nanorod arrays and 2D g-$C_3N_4$ nanosheets based composite photocatalysts for photocatalytic hydrogen ($H_2$) production and degradation of azo dyes under solar light irradiation.

**OP 69**

# CHELATOR-DRIVEN SYNTHESIS OF NANO-ELECTROLESS COPPER ON EPOXIDES: INSIGHTS INTO SURFACE ARCHITECTURE AND ELECTROCHEMICAL PROPERTIES

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This investigation explores the electroless deposition of copper nanoparticles onto epoxy substrates using glyoxylic acid as the reducing agent. The deposition process was conducted under alkaline conditions, with the pH precisely maintained at $11.0 \pm 0.25$ using potassium hydroxide. Two distinct bath formulations were employed: one containing glucose alone, and the other comprising a chelator mixture of glucose and fructose to enhance complexation efficiency. Azole-based stabilizers were introduced to fine-tune bath parameters and improve deposition control. Comprehensive characterization of the resulting copper coatings was performed using Scanning Electron Microscope-energy Dispersive Analysis of X-ray (SEMEDAX), Atomic force microscopy (AFM), X-ray Photoelectron spectroscopy (XPS), cyclic voltammetry (CV), Tafel analysis, and electrochemical impedance spectroscopy (EIS). The bath containing the mixed chelators demonstrated superior stability and yielded high-quality, uniform copper deposits with enhanced surface and electrochemical properties. Keywords: Chelator, glucose, fructose, nanoparticles, stabilizers.

**OP 70**

# ELECTROCHEMICAL DETERMINATION OF NITRITE IN SPICES USING SILVER NANOPARTICLES ADORNED CLAY NANOCOMPOSITES

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Synthesis of silver nanoparticles integrated onto aminopropyltrimethoxysilane functionalized halloysite nanotubes (AgNPs@HT) allowed for the successful detection of nitrite levels in spices samples. UV-Visible, FT-IR, XRD, FE-SEM, and TEM images were used to analyze the prepared AgNPs@HT nanocomposites. Under optimized experimental conditions, the voltammetric technique was used to detect nitrite electrochemically at an $E_p$ of + 0.69 V after the AgNPs@HT nanocomposites were coated with GCE. Studies employing chronoamperometry and differential pulse voltammetry have been conducted to ascertain the diffusion coefficient, high current sensitivity, rate of the nitrite reaction, and enhanced peak resolution of the modified electrodes. Finally, the amperometry approach was used to estimate the LOD and sensitivity of nitrite, which came out to be 0.09 nM and 2208 µA $mM^{-1}$ $cm^{-2}$. High anti-interference, exceptional repeatability, long-term stability, sensitivity, and other improved qualities are provided by AgNPs@HT/GCE. The suggested sensor has strong recovery rates (R.S.D. < 5%) for the effective detection of nitrite in spices samples.

**Keywords**: Silver nanoparticles, Aminopropyltrimethoxysilane, Clay nanotubes, Nitrite, Amperometry,Spices.

**OP 71**

# CHEMICALLY SYNTHESIZED PPY–$TIO_2$ NANOCOMPOSITES EXHIBITING ENHANCED $CO_2$ SENSING THROUGH COMPOSITION TUNING

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Pure polypyrrole (PPy) and its nanocomposites decorated with titania nanoparticles were synthesized by in situ chemical oxidative polymerization using $FeCl_3$ as an oxidant. Series of PPy-$TiO_2$ nanocomposites were obtained by varying the weight percentage of $TiO_2$ nanoparticles (5%,10%,15%,20%,25%,30%) with the Pyrrole monomer. Synthesized organic-inorganic hybrid composites have been characterized using XRD, FT-IR, UV-visible, TGA and SEM. XRD results demonstrates the amorphous nature of PPy while its composites with $TiO_2$ exhibit crystalline nature. The infrared spectroscopy reveals the presence of interaction between conducting PPy and $TiO_2$. The TGA data infers that the obtained nanomaterials have good thermal stability over temperature range and shows good sensitivity, response and recovery times at the room temperature. The micrograph of the synthesized pure polypyrrole (PPy) showcases an irregular granular morphology characterized by agglomerated spherical particles dispersed across the surface. Compared to pure PPy, the incorporation of $TiO_2$ appears to improve the density of the agglomerated grains, resulting in a more cohesive network. Nanocomposites were screen printed on glass substrate to obtain gas sensors which were utilized as a potential application towards detection of $CO_2$ gas. The varying composition of $TiO_2$ nanocomposite is evident of change in gas sensing response towards $CO_2$.

**Keywords**: Nanocomposites, Polypyrrole, $TiO_2$, $CO_2$ sensor.

**OP 72**

# REMOVAL OF CATIONIC DYE FROM AQUEOUS SOLUTION BY USING AGRICULTURAL WASTE ACTIVATED CARBON

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*Thevitia Neriifolia Juss* Activated Carbon (TNJAC) was prepared using the carbonisation of the process. The prepared was TNJAC characterised by using X-ray diffraction (XRD), scanning electron microscopy (SEM). The *Thevitia Neriifolia* Juss Activated Carbon was used to remove Methylene Blue (MB) dye from the aqueous solution. The effects of pH, adsorption time, initial concentration of MB, dose, and temperatures were studied. The experiment data were analysed by pseudo-first-order, pseudo-second-order, Elovich, and intra-particle-diffusion kinetic models. Among these models, the pseudo-second-order was the best fit model and the adsorption rate constant of MB was 0.001 g/mg. min. The adsorption isotherms were studied by fitting the experimental data to the Langmuir and Freundlich models. The results indicated that the Langmuir model was the fittest model for describing the isotherms of the MB adsorption on TNJAC. When the temperature increased from 303 to 323K, the maximum adsorption capacity of MB decreased from 318 to 81.0 mg/g. The thermodynamic study showed that the MB adsorption process onto TNJAC was a spontaneous and exothermic process with ΔG0, ΔH0 negative. The MB dye adsorption mechanism was discussed, involved interactions, such as electrostatic attraction and H-bonding. TNJAC could be regenerated and reused to adsorb anionic dye.

**Keywords:** Activated Carbon, Methylene Blue, adsorption, Langmuir and Freundlich models.

**OP 73**

# NOVEL AND STABLE HYDROGELS AS CALORIMETRIC SENSORS FOR SELECTIVE DETERMINATION OF HAZARDOUS METAL IONS

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Novel and stable hydrogels as effective calorimetric sensors for the selective detection of hazardous metal ions were developed. These hydrogels exhibit excellent stability, sensitivity, and specificity due to their well-structured polymer network and tailored functionalization. The synthesized gelators have high stability for nearly a month. There by transport of these gelators and detection of metal ions is feasible. These sensors are stable even at room temperature. This study investigates the effect of selective gelating sensor using randomized controlled trial of metal ion concentration. We examined the impact of the gelator sensor on various hazardous metal cations and found that the synthesized hydrogel selectively detects metal ion. All the synthesized hydrogels and gelator-indicator complex were characterized by SEM analysis. Their porous architecture, as confirmed by SEM analysis, ensures efficient ion diffusion and interaction, enhancing their detection capabilities. Their strong crosslinking and high-water retention capacity contribute to prolonged stability and consistent performance in diverse environmental and industrial conditions. The selectivity of these sensors minimizes interference from non-target ions, ensuring accurate and reliable results. These hydrogels provide a cost-effective, eco-friendly, and scalable solution for monitoring toxic metals in water, food, and industrial effluents. Their simplicity and efficiency make them a promising alternative to conventional detection methods.

**Key words:** Hydrogels, calorimetric sensors, toxic metal ion detection, ecofriendly method.

**OP 74**

# AGRO-WASTE CONVERSION INTO VALUE-ADDED WOUND CARE: WATERMELON RIND-BASED BIO-GEL SPRAY DEVELOPMENT

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Watermelon rind, an agro-industrial waste, harbours bioactive compounds with potential therapeutic benefits. Our project aimed to develop and evaluate a bio-gel spray using watermelon rind extract for wound healing applications. The extract exhibited antioxidant activity and antimicrobial efficacy, making it an ideal candidate for wound care. This formulation showed significant antimicrobial activity against common wound pathogens and promising antioxidant properties. In vitro studies demonstrated enhanced cell proliferation and wound closure rates, while in vivo studies accelerated wound healing with improved tissue regeneration and collagen deposition. The developed bio-gel spray is biocompatible and shows great potential for managing wounds, offering a sustainable, Eco-friendly alternative for wound care. This Green Cure project highlights the potential of natural waste conversion into valuable healthcare products. Watermelon rind extract can induce faster wound recovery and protection against infection, making it an attractive option for wound care. Unlike synthetic medicines, which can cause side effects and are often unaffordable for poor people, this biogel spray is affordable, easy to apply, hygienic, and promotes faster absorption, better wound healing protection, and patient comfort. By converting agro-waste into valuable products, farmers can generate income and increase their economic benefits, contributing to a more sustainable and equitable healthcare system.

**Keywords:** Watermelon rind extract, Agro-industrial waste, Bioactive compounds, Bio-gel spray, Biocompatible formulation, Antioxidant activity.

**OP 75**

# SUSTAINABLE EDIBLE PACKAGING FROM BANANA PSEUDOSTEM FOR EXTENDING MUSHROOM SHELF LIFE: A WASTE-TO-WEALTH APPROACH

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Mushroom production has increased rapidly across the globe, now crossing more than ten million tons every year. Their high nutritional value and versatility in cooking make them popular, but fresh mushrooms spoil very quickly. Because they contain nearly 85–95% moisture and undergo rapid browning and microbial growth, almost one-third of harvested mushrooms become unfit for consumption within just a few days at room temperature. This short shelf life leads to major economic losses for farmers, distributors, and retailers. To slow down spoilage, mushrooms are usually packed in materials like polyethylene or polypropylene. These components can be extracted and processed into transparent, flexible, and biodegradable edible films. Using banana stem waste for packaging adds value to a neglected agricultural by-product and supports a circular economy by turning waste into a useful material.To further improve preservation, natural antimicrobial compounds such as chitosan, essential oils, or green-synthesized nanoparticles can be coated onto these films. These antimicrobial layers help slow down microbial growth, reduce browning, and retain the texture and nutritional quality of mushrooms during storage.This project aims to develop a banana pseudostem-based edible film combined with an antimicrobial coating to extend mushroom shelf life. The work involves extracting biomaterials, preparing edible films, applying antimicrobial layers, and evaluating their physical, mechanical, and microbiological performance. This approach offers an environmentally responsible alternative to synthetic plastics while reducing post-harvest mushroom losses and creating value from agricultural waste.

**OP 76**

# NATURAL PEEL EXTRACT BLENDED MORINGA GUM COMPOSITE FILMS FOR FOOD PACKAGING APPLICATION

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Moringa Gum was blend with two different natural peel extract (onion peel and potato peel) extract to get a thin composite film by solution cast method. The morphology of the films was studied using scanning electron microscope. Physio-mechanical properties were analysed and compared with the pristine film. From the obtained results, it was found that the water solubility, thickness, transparency, mechanical strength, antibacterial activity of the prepared composite films showed better improvement when compared to the parent film. On exact comparison, potato peel extract – moringa gum composite film gave overall best result that was followed by onion peel extract-moringa gum composite film and pure moringa gum film due to the interaction of their functional groups. Thus, the synthesised films will act as an ideal material for food packaging application.

**OP 77**

# CULTIVATION OF *CHLORELLA VULGARIS* FOR NUTRACEUTICAL APPLICATION AND BIO DIESEL PRODUCTION FROM WASTE WATER

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Organic and inorganic substances which were released into the environment as a result of domestic, agricultural and industrial water activities lead to organic and inorganic pollution. In the recent past considerable interest have been seen all over the world in employing microalgae for wastewater treatment. Algae can be used to treat both municipal and industrial wastewater. Algae play a major role in aerobic treatment of waste in the secondary treatment process. This secondary effluent is, however, loaded with inorganic nitrogen and phosphorus and causes eutrophication and more long-term problems because of refractory organics and heavy metals that are discharged. Algae - based municipal wastewater treatment systems are mainly used for nutrient removal (removal of nitrogen and phosphorous). The added benefit is the resulting biomass that can be used as nutraceutical and bio fuel feedstock.Microalgae that contain large quantities of high-quality EPA and DHA, the omega-3 fatty acids responsible for proper brain function and immunity health are being commercialized as sustainable alternatives to fish oil.

This paper evaluates the use of *Chlorella vulgaris* for Municipal waste water treatment and resulting biomass as nutraceutical and Bio fuel. Biomass production factors of Isolated *Chlorella Vulgaris* strain were optimised by Plackett-Burman Design followed by response surface methodology using Central-Composite design. Waste Water were diluted according to the Optimised factors and *chlorella vulgaris* was cultured, which utilises the pollutants in waste water for their growth and resulting biomass was used for Bio lipid (Nutraceutical) extraction. Fatty Acid Methyl Esters (Bio Deisel) present in bio lipid was analysed by gas chromatography.

**OP 78**

# A PREPARATION OF BENEFICIAL PRODUCT FROM THE WASTAGE OF GROUNDNUT SHELL

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Paper production through chemical pulping has been identified as one of the ideal avenues of exploring the uses of groundnut shells as they are rich in cellulose. Ideally, the cellulose can be used to synthesize fibers that can be converted into useful paper products. The aim of present work is to evaluate peanut pod powder as natural textile dyestuff. The work consists of three steps, i.e. extraction, characterization and dyeing processes. Finally, dyed fabric has been subjected to different textile laboratory tests e.g., color fastness, light fastness, washing fastness and rubbing fastness (dry and wet). we conducted a pot experiment to analyze the possibility of using groundnut shell compost as an alternative to chemical fertilizer in the cultivation of vegetable plants. Groundnut shells, the outer coverings of peanuts, are a popular raw material for activated carbon production. These shells are a sustainable and eco-friendly alternative to other raw materials such as coal and coconut shells. Using groundnut shells for activated carbon production not only helps reduce waste but also promotes sustainability in industrial processes. In this work, we aimed to develop a facile and cost-effective method for the green synthesis of nano carbons (NCs) from Groundnut shell, a natural biowaste and renewable resource. The synthetic process involves a single step pyrolysis technique in a nitrogen atmosphere at different temperatures (550, 750 and 950 °C). Using KOH activation and thermal treatment, carbon nanosheets were synthesized from groundnut shells. In this study, groundnut shell powder (GSP) was characterized using SEM and TEM Analysis.X-ray diffraction (XRD), Fourier transform infrared (FTIR), X-ray fluorescence (XRF),

**Key Words:** Groundnut Peel, Paper Pulp, Natural Dyes, Natural Fertilizer, Activated Carbon, Nanoparticles, Nanosheet, SEM and TEM Analysis.

**OP 79**

# STUDIES ON THE STRUCTURAL, NON-LINEAR OPTICAL, AND ANTIMICROBIAL ACTIVITY OF TERT-BUTYL AMINE METHYL-P-TOULENE SULPHONATE SINGLE CRYSTAL

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Tert-butylamine methyl-P-toluene sulphonate (BAMTS), an organic single crystal, was grown at room temperature using the slow evaporation method. SXRD investigations reveal that BAMTS belong to the monoclinic system and space group C 2/c with Z = 8. The functional groups are found using FTIR analysis. UV-Vis spectroscopy, which includes optical absorption, is used to calculate the band gap energy and optical characteristics. The cut-off wavelength is identified as a 254 nm. The Band gap energy is found to be 3.0209 eV. BAMTS' SHG efficiency is 1.8 times than that of standard KDP. Fluorescence investigations were used to assess the luminous effect. The antibacterial and antifungal activities of formed crystals are more effective against species than references.

**Keywords:** organic single crystal, monoclinic system, lattice parameters, optical absorption, luminous effect, SHG efficiency.

**OP 80**

# SYNTHESIS, CHARACTERIZATION, AND BIOLOGICAL INVESTIGATION OF BIPYRIDINE AND AMINO-FUNCTIONALIZED METAL-ORGANIC FRAMEWORKS: A THEORETICAL AND EXPERIMENTAL APPROACH

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In this study, we synthesized and extensively characterized two amino-functionalized metal-organic frameworks (MOFs), Ni-BPy and Ni-ATPA, using nickel as the metal source. These MOFs were employed for biological applications, offering a cost-effective and affordable technique in the energy sector due to their synthesis from inexpensive and accessible metal salts and ligands.Characterization via FTIR, Raman, PXRD, TGA, and FESEM confirmed the formation of Ni-BPy and Ni-ATPA. Under optimized conditions, high-quality MOFs were produced. Notably, the Ni-MOF composite exhibited a mesoporous graphitic structure.The Ni-based MOFs (Ni-ATPA & Ni-BPy) demonstrated unique antibacterial capabilities, making them promising candidates for drug delivery applications. The Ni-MOF composite showed significantly improved antibacterial ability with low cytotoxicity. Further density functional theory investigations explained the favorable biological effects. This study paves the way for developing Ni-MOF composites with antibacterial and anti-inflammatory properties for enhanced drug release application.

**OP 81**

# $ZnFe_2O_4$ -CATALYSED AND MICROWAVE-IRRADIATED ONE-POT GREENSYNTHESIS OF BENZIMIDAZOLE DERIVATIVES

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A range of 2-substituted benzimidazole derivatives were produced by effectively condensing substituted aldehydes with aromatic diamines under microwave irradiation using a magnetically recoverable heterogeneous catalyst. Zinc ferrite ($ZnFe_2O_4$ ) nanoparticles were utilized as a sustainable nano catalyst, leveraging their substantial surface area, robust magnetic characteristics, and thermal stability to enhance the transformation process under mild and environmentally friendly conditions. The combined influence of microwave irradiation and ZnFe2O4 catalysis markedly decreased reaction durations and produced superior yields in comparison to traditional heating techniques. The easy magnetic separation of the catalyst from the reaction mixture eliminates the need for filtration and allows for rapid recovery, representing a key advantage of this catalytic system. Over the course of five cycles, the $ZnFe_2O_4$ nanoparticles showed steady catalytic activity with only a slight decline in efficiency. They were also highly recyclable and shown considerable durability. This component enhances the protocol & cost-efficiency and durability.

The method adheres to multiple principles of green chemistry, such as reduced energy consumption, minimal or solvent-free conditions, avoidance of hazardous reagents, and streamlined work-up processes. As an alternative for traditional benzimidazole production, the process is safe, easy to scale up, and experimentally straightforward. The study demonstrates an efficient and environmentally friendly method for synthesizing benzimidazole derivatives utilizing a recyclable $ZnFe_2O_4$nano catalyst under microwave irradiation. The results demonstrate the promise of magnetically recoverable ferritenanomaterials in sustainable heterocyclic synthesis.

**OP 82**

# SYNTHESIS AND CHARACTERIZATION OF MESOPOROUS SILICA REINFORCED MALEIMIDO TERMINAL THIOPHENYL PENDANT PYRIDINE CORE POLYBENZOXAZINE (SBA-15/PBZ) HYBRID NANOCOMPOSITES

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A new type of benzoxazine (MI-BZ) monomer was synthesized from maleimido terminal thiophenyl pendant pyridine core dimine by Mannich condensation reaction. Mesoporous silica incorporated polybenzoxazine (SBA-15-15/PBZ) nanocomposties were prepared from benzoxazine monomer and SBA-15 with various weight percentages of functionalized SBA-15. The structural formation of BZ monomer and their PBZ nanocomposites were validated from physico-chemical characterization techniques. The hybrid nanocomposites showed better thermal stability and elevated glass transition temperature than that of neat PBZ. The flame retardancy and lower dielectric constant were due to the reinforcement of SBA-15in the PBZ networks. The prominent fluorescent emissions evidenced the successful incorporation of SBA-15onto the PBZ matrices. The effective reinforcement of SBA-15 was revealed from the characteristic diffraction peaks corresponding to SBA-15in the nanocomposites. The incorporation and homogeneous dispersion of SBA-15in the PBZ matrices were evidenced from morphological studies.

**Keywords:** Polybenzoxazine, mesoporous silica, nanocomposites, glass transition temperature, thermal stability, dielectric materials, fluorescence and morphology.

**OP 83**

# EXPLORATION OF PHYTOCOMPOUNDS IN *ABELMOSCHUS MOSCHATUS* FLOWERS USINGHPLC, UV-VIS AND FTIR TECHNIQUES

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Medicinal communities in many developing countries. The bioactive components of Abelmoschus *moschatus* flowers have been evaluated using HPLC, UV VIS and FTIR. The phytochemical screening of Abelmoschus *moschatus* flowers showed that the presence of flavonoids, terpenoids, tannin, saponins, glycosides, triterpenoids, phenol, anthroquinones were present in aqueous, ethanol and ethyl acetate extracts. The UV-VIS profile showed the occurrence of peaks at 207-380 nm reveals the presents of flavonoids in the *Abelmoschus moschatus*. The results of FTIR analysis confirmed the presence of phenol, alkanes, Alkenes, alcohol, aromatic, Aliphatic amines and amine compound. The results of this study offer a platform of using *Abelmoschus moschatus* flower as herbal alternative for various diseases including diabetic, cardiovascular etc. The results of this study offer a platform of using *Abelmoschus moschatus* flowers as herbal alternative for various diseases including cancer and diabetic. plants are assuming greater importance in the primary health care of individuals

**Keywords:** GC MS, HPLC, UV-VIS, FTIR, *Abelmoschus moschatus*

**OP 84**

# A STUDY ON DEPOLYMERIZATION OF KRAFT LIGNIN WASTES USING LACCASE MEDIATOR SYSTEM TO MITIGATE POLLUTION PROBLEM IN PAPER INDUSTRY: AN ECO-FRIENDLY APPROACH

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Kraft lignin, the dominant byproduct generated during the kraft pulping process, is produced in millions of tons annually, with nearly 300 kg obtained from every 1000 kg of wood pulp. Although it is a structurally rich aromatic biopolymer, kraft lignin remains critically underutilized as a renewable resource. Its complex, heterogeneous, and highly recalcitrant structure poses major environmental and industrial challenges. The accumulation of untreated lignin in waste streams results in elevated chemical oxygen demand (COD),BOD, high salinity, toxicity level, leading to soil infertility and water pollution and also contributes to greenhouse gas emissions when disposed through incineration. It also incurs high operational costs, requires skilled labor and frequent maintenance. Conventional lignin management methods like landfilling, combustion, and chemical depolymerization have been adopted for the treatment of kraft lignin wastes. But, those techniques have not been effective as they are energy intensive, generate secondary pollutants and also require additional investment. Hence, alternative techniques have to be developed to avoid such problems. The study proposes an eco-friendly laccase-mediated biodegradation strategy to achieve efficient depolymerization of kraft lignin. The maximum lignin degradation was achieved using 1.0–1.5 U/mL laccase under optimal conditions of pH 5.5 and 32 °C for 48 hours. The incorporation of redox mediator systems significantly accelerated the depolymerization process, reducing the total degradation time to 24 hours, while enhancing oxidative cleavage of β-O-4 linkages. UV–Vis and FTIR analyses confirmed major structural alterations such as aromatic ring oxidation, formation of carbonyl groups, and disruption of ether linkages, collectively indicating extensive depolymerization.

The biodegradation efficiency achieved ranged from 75-90%, varying with the molecular weight distribution of the kraft lignin. The resulting low-molecular-weight lignin-derived oligomers demonstrated high potential for industrial valorization. The study underscores the promise of laccase-mediated lignin transformation as a sustainable approach that aligns with circular bioeconomy principles by converting industrial waste into valuable bio-based products

**Keywords**: Kraft lignin, laccase, biodegradation, laccase–mediator system, depolymerization, circular bioeconomy, sustainable bioprocessing.

**OP 85**

# NANO-AGROCHEMICALS AS SUBSTITUTES FOR INSECTICIDES: INSECT TOXICITY AND FUNCTIONAL MARKER ALTERATION OF GREEN ZNO NANOPARTICLES USING *CARALLUMA INDICA* SEED

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Nowadays, the use of nano-agrochemicals has become essential for worldwide agricultural sustainability. The insecticide primary functional markers of AChE, GST, SOD, and CAT enzymes are targeted by insecticide development. The reduction of AChE and GST enzymes by the insecticide, which responds to increased oxidative stress markers (SOD and CAT), stimulates DNA damage, lipid peroxidation, and protein oxidation, causing insect toxicity. The aim of the present study is the insecticidal and functional marker evaluation of the green synthesized zinc oxide nanoparticles using aqueous extract of *Caralluma indica* seed (Ci-ZnONPs) against the storage pest *Tribolium castaneum*. Ci-ZnONPs had a potential *T. castaneum* adult toxicity with dose-dependent activity ($R^2$ = 0.9), which is contributed to by the zinc ions reducing and capping the agent of polyphenol and terpenoid derivatives with reduced zinc ions into zinc oxide nanoparticles ($Zn^{2+}$ into $Zn^0$ ). The sub-lethal concentration of Ci-ZnONPs adult toxicity 1/10 dose (1/10 LC50) was notable for insect biochemical changes such as inhibition of the detoxification enzyme GST and significantly increased oxidative stress markers such as SOD and CAT, compared to the control ($p$<0.05). Additionally, the AChE enzyme is inhibited by Ci-ZnONPs, which results in increased ACh substrate and stimulates insect toxicity, compared to the control ($p$<0.05). Overall, *C. indica* seed-mediated zinc oxide nanoparticles are a potential eco-friendly pesticide and are an alternative to synthetic pesticides with application to pest management in the agriculture sector.

**Keywords:** ZnONPs, Caralluma indica seed, Insecticide functional targets, AChE, GST, SOD.

**OP 86**

# ECOLOGICAL AND ETHNOBOTANICAL SIGNIFICANCE OF TREE SPECIES IN AIR POLLUTION MITIGATION AND URBAN GREENING

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This paper explores the ecological functions, botanical characteristics, and cultural importance of six major tree species which include *Ficus religiosa*, Azadirachta *indica,Syzygium cumini*, *Polyalthia longifolia,**Tamarindus indica and Peltophorum pterocarpum*** with a focus on their role in mitigating air pollution and improving urban environments. These tree species are widely distributed across South and Southeast Asia and exhibit significant ecological adaptability, medicinal utility, and cultural relevance.Plant leaves have large surface area and they function as efficient dust trapping device. The study focusses on the importance of different plants based on the APTI. The evaluated plants show good performance in different zones by acting as sink for elimination of air pollutants in different zones of study. The study indicates literature-based evidence on their physiology, environmental interactions, and socio-religious applications to evaluate their potential in sustainable urban planning and public health enhancement.

**Keywords:** Tree species, air pollution, ethnobotany, urban forestry, traditional medicine

**OP 87**

# PHOTOREDUCTION ASSISTED CHELATION PRECIPITATION USING $CO^{III}(Pn)_2$ $CL(L)^{2+}$ FOR HEAVY METAL COMPLEX MITIGATION IN WASTEWATER TREATMENT

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Photoinduced electron transfer between $TiO_2$ nanomaterial and $Co^{III}(pn)_2$ $Cl(L)^{2+}$ complexes were examined under controlled binary solvent environments ($H_2$ O/methanol and $H_2$ O / isopropanol). The study employed Co(III) complexes [L = $RC_6$ $H_4$ $NH_2$ ; R = p-$OCH_3$ , m-$OCH_3$ , and H] as chelating–precipitating agents to remove Cu(II), Ni(II), Zn(II), and Pb(II) from contaminated wastewater. Systematic evaluation of pH and temperature effects revealed enhanced metal-ion removal at lower pH and pollutant concentrations. The Co(III) chelates yielded markedly lower metal leaching levels than conventional hydroxide precipitation. AAS analysis confirmed efficient simultaneous removal of Cu(II) and Ni(II) across solvent systems. Thermodynamic parameters indicated a spontaneous, endothermic adsorption process at elevated temperatures. The $TiO_2$ /Co(III)$(pn)_2$ $Cl(L)_2^+$ system exhibited robust remediation performance in simulated effluents, demonstrating strong potential for industrial wastewater treatment.

**Keywords:** Coagulation, Photoreduction, Chelation, Heavy metal remediation

**OP 88**

# INFLUENCE OF MERCAPTO AZOLE ADDITIVES ON THE CHARACTERISTICS OF AUTOCATALYTIC COPPER NANO FILM DEPOSITION

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This article aims at analysing the influence of structurally related two azole additives such as 2-Mercaptobenzothiazole (2-MBT) and 2-Mercaptobenzimidazole (2-MBI) in the rate of autocatalytic copper nano film depositions. The effect of these stabilizers on the characteristics of both the electroless plating bath and electroless copper deposition is also studied. Dimethylamine borane (DMAB) is employed as the reducing agent and sorbitol as complexing agent in the copper methanesulphonate bath. Potassium hydroxide acts as the suitable pH regulator to modify the properties of copper nano deposits. 1 ppm of the azole additives are added in this eco-friendly bath and optimized at a pH of 12.75 ± 0.25 at a temperature of 28±2 °C. The results obtained from various studies imply that 2-MBT had an inhibiting effect on copper deposition, whereas 2-MBI accelerated the deposition rate. The physical properties like deposition rate, thickness and activation energy are calculated to support the stabilizing effects of 2-MBT and 2-MBI. Surface morphology of the copper deposits is characterized by Scanning Electron Microscopy (SEM) and Atomic Force Microscopy (AFM) techniques. Structural properties such as crystallite size and specific surface area of plain bath and additives laden baths are investigated using X-ray diffraction studies.

**Keywords:** 2-mercaptobenzimidazole, 2-mercaptobenzothiazole, dimethylamine borane, sorbitol, surface morphology**.**

**OP 89**

# NANOCATALYSIS AT THE FRONTIER OF SUSTAINABLE ENVIRONMENTAL INNOVATION

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Pesticides are extensively used in agriculture to boost crop productivity. However, despite their benefits, they pose significant environmental risks by leaching into nearby water streams. In developing countries like India, farmers often lack proper training regarding pesticide dosage, leading to excessive application. This overuse results in pesticide accumulation in soil which eventually contaminates nearby water bodies through runoff. Conventional methods such as filtration, electrolysis, precipitation, ion exchange, and adsorption are employed to remove dissolved pesticides. Nanoparticles can facilitate the mineralization of dissolved pesticides through photocatalytic processes. Thus, harnessing the distinctive properties and diverse applications of nanocatalysts is essential for fostering a greener and more sustainable environment.

In this study, nanomaterials were synthesized using plant extracts through an eco-friendly green synthesis method. The resulting nanoparticles were characterized and assessed for their efficacy in environmental applications, particularly for pesticide degradation. Diaphosphate fertilizer was selected as the target pesticide, given its prevalent use in Indian agriculture. A highly dilute pesticide solution with an absorbance of less than 1 was prepared. Green-synthesized nanoparticles were then introduced into this solution, and the reaction was conducted under light exposure. UV readings were recorded at 1-hour intervals to closely monitor the degradation process. After several hours, a significant reduction in the UV spectra of the pesticide solution was observed, indicating the effectiveness of the synthesized nanoparticles in facilitating pesticide mineralization. This could serve as a pivotal advancement in mitigating pesticide contamination across soil, water, and the broader ecosystem.

**Keywords**: Nanocatalysis; Sustainable; Environment; Nanotechnology; Green synthesis; Pesticides

**OP 90**

# GREEN CHEMISTRY BASED FUNCTIONAL BIOMATERIAL FOR INDO AIR SUSTAINABILITY

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Functional Cellulose Nanofiber Films (CNFs) are gathering attention in material science due to their environmentally sustainable properties. In this study, Pt nanoparticles and dendrimer-loaded organoclay were immobilized on films to create functional CNFs for the breakdown of indoor air pollutants (IAPs), i.e. the formaldehyde. In order to achieve nanometer thickness without sacrificing length, the 2,2,6,6-tetramethylpiperidine-1-oxyl (TEMPO) radical mediated the oxidation reaction that produced the thin cellulose nanofibers. Using cellulose nanofibers as a substrate or film also has several advantages, such as being a renewable natural resource, easily functionalized, and naturally decomposing. Pt nanoparticles are used as an environmental catalyst for the degradation of IAPs, whereas dendrimer-loaded organoclays were used as gas adsorbed and to give the film mechanical strength. In our previous study, we have found that dendrimer plays the role of a reservoir for selective gas capture and carrier of electron/proton on the CNFs. To implement this, an eco-friendly catalyst film comprising dendrimer, clay, and Pt catalyst was made with different loading ratios and evaluated using a variety of analytical techniques before IAPs were broken down.

**OP 91**

# ASTROCHEMICAL NANO-ARCHITECTURES AS TEMPLATES FOR SUSTAINABLE SMART MATERIALS: A THEORETICAL FRAMEWORK

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Astrochemical environments are natural laboratories wherein complex chemical and physical processes under extreme conditions give unique insights into the formation and transformation of materials at the nano-scale. From interstellar molecular clouds to protoplanetary disks and late-stage stellar envelopes, nano-architectures of high organization in these cosmic regions drive molecular evolution, surface reactions, and hierarchical self- assembly. This theoretical study explores how these astrochemical nano-architectures can be translated into foundational design principles for sustainable and smart material systems on Earth. By considering stellar nucleosynthesis pathways, elemental abundance gradients, dust-grain catalysis, and the self-organization processes across the Hertzsprung–Russell diagram, the work establishes conceptual parallels with functional material properties comprising adsorption, catalysis, charge transport, self-healing, and environmental responsiveness.

This model allows the design of low-carbon, circular-economy material variants without resource-intensive synthesis or experimental validation by incorporating principles into the framework from cosmic chemistry. The study emphasizes how scaling laws, elemental periodicity, and interstellar surface processes may inform AI-assisted theoretical material prediction and digital twin simulations in pursuit of this fully conceptual yet scientifically grounded approach. Such an interdisciplinary synthesis here shows that astrochemical processes could serve as inspirations for finding innovative routes toward smart, environmentally adaptive materials by spanning astrophysics, chemistry, and sustainable engineering. The work places astrochemical nano-architectures as a potent paradigm to progress next-generation materials at the heart of global sustainability challenges.

**Keywords:** Astrochemical nano-architectures; Interstellar dust chemistry; Stellar nucleosynthesis; Sustainable smart materials; Theoretical material design

**OP 92**

# ABUNDANCE OF CHEMICAL SUBSTANCES IN ORION NEBULA AND CELESTIAL OBJECTS: A DATAANALYTIC ASTROCHEMICAL STUDY

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This research explores the abundance and distribution of chemical substances in the Orion Nebula and other celestial objects using astrochemical datasets and data analytic techniques. Through spectral analysis, observational data, and computational modeling, we examine elemental and molecular compositions, trace chemical evolution, and identify formation environments in interstellar medium (ISM) conditions. The study leverages modern data analytics, machine learning, and visualization techniques to interpret large datasets from observatories like ALMA, Hubble, and Herschel. This study presents a graphical representation of the chemical composition found within the Orion Nebula and selected celestial bodies, aiming to visualize the spatial and elemental distribution of key molecules and atoms in these astronomical environments.

**Keywords:** Orion Nebula, Astrochemistry, Molecular Clouds, Spectroscopy, Data Analytics, Abundance Analysis, Interstellar Medium.

**OP 93**

# ISOTHERMS STUDIES - ADSORPTION OF REACTIVE RED DYE FROM AQUEOUS SOLUTION ONTO ACTIVATED CARBON PREPARED FROM COTTON STALK

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Dyes are one of the most hazardous chemical compound classes found in industrial effluents and need to be treated since their presence in water bodies reduces light penetration, precluding the photosynthesis of aqueous flora. In the present study a new activated carbon was prepared from Cotton stalk using phosphoric acid in a Tubular furnace and designated as Cotton Stalk Tubular furnace Carbon (CSTC) was used as an adsorbent for the successful removal of Reactive Red dye from aqueous solutions. The effect of various operating parameters such as initial concentration of dye, contact time, adsorbent dosage and initial pH was investigated in order to find the optimum adsorption conditions. Different isotherms were used to identify the possible mechanism of the adsorption process. The optimum pH for removing of RR dye from aqueous solutions was found to be 2 and predicted maximum adsorption capacity for RR dye was obtained as 71.43 mg/g for the chosen experimental conditions. The equilibrium data were fitted to the Langmuir, Freundlich, Temkin and Dubinin-Raduskevich isotherm equations. Significance of the isotherm constant values was discussed. finally, it was concluded that Cotton Stalk Tubular furnace Carbon (CSTC) can be used for Reactive Red dye removal from aqueous solutions.

**Keywords:** Adsorption; Phosphoric acid activated Cotton stalks Carbon; Isotherms; Reactive Red dye.

**OP 94**

# ISOTHERM, KINETIC AND THERMODYNAMIC STUDIES OF DIRECT BLUE 2B ONTO HYDROCHAR

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In the present study, the adsorptive removal of direct blue (2B) from aqueous solution was studied using the novel adsorbent hydrochar prepared from hydrothermal carbonization of wood saw dust. The adsorption of direct blue 2B onto hydrochar was carried at different adsorbent amount at different pH values and temperatures using different dye concentrations. The characterization studies of the hydrochar were performed using Elemental analysis, Fourier-Transform infrared spectroscopy (FT-IR) and scanning electron microscope (SEM). The adsorption percentage of dye reached the maximum with 68% at pH = 7 at 27 °C. Furthermore, Langmuir model fits well for the adsorption. The maximum adsorption capacity obtained from Langmuir model was found to be 83 mg/g for hydrochar at pH = 7 and 27°C. The adsorption kinetics was fitted well by pseudo-second order model and the calculated thermodynamic parameters indicated that dye adsorption onto hydrochar was spontaneous and an endothermic.

**Keywords:** Hydrochar, hydrothermal carbonization, Direct Blue 2B, Kinetic studies, Isotherm studies

**OP 95**

# SYNTHESIS AND PROPERTY EVALUATION OF ZnO/PbZ NANOCOMPOSITES: OPTICAL AND THERMOMECHANICAL ASPECTS

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A novel series of polymer-zinc oxide nanocomposites were successfully synthesized using in situ dispersion of zinc oxide (ZnO) nanoparticles within a liquid benzoxazine (PBZ) polymer matrix. This approach facilitated excellent filler dispersion, which was confirmed through comprehensive morphological and spectroscopic analysis using Fourier-transform infrared spectroscopy (FTIR), ultraviolet-visible spectroscopy (UV-Vis), and scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDS).

The study systematically investigated the influence of increasing nano-ZnO loading on the resulting material properties. Mechanical testing revealed that the incorporation of ZnO nanoparticles significantly enhanced the tensile strength and elastic modulus of the PBZ nanocomposites, indicative of strong interfacial adhesion between the filler and the polymer matrix. The thermal stability and resistance to ageing were evaluated using thermogravimetric analysis (TGA) following air ageing studies conducted across a temperature range of 50°C to 100°C. The results demonstrate that the synthesized nanocomposites exhibit superior thermomechanical performance compared to the pristine polybenzoxazine matrix.

**Keywords:** Nanozincoxide, morphology, benzoxazine, nanocomposites, thermal stability.

**OP 96**

# DESIGN AND DEVELOPMENT OF Ni MOF NANOSHEET-INFUSED CA-MODIFIED PEI MEMBRANE FOR ENHANCED CONGO RED ADSORPTION

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Adsorption by membrane technology has proven to be an effective solution for effluent purification in light of the increasing concern regarding dye-contaminated water, which can have long-term detrimental effects on biotic components. In this work, highly efficient membranes with excellent adsorptive characteristics were fabricated by incorporation of nickel metal-organic framework (Ni-MOF) in two different compositions (0.25 and 0.5%) into a citric acid (CA)-modified polyetherimide (PEI) membrane using a simple phase inversion technique with a focus on removing Congo red dye. Fourier-transform infrared (FTIR) spectroscopy, X-ray diffraction (XRD), field emission-scanning electron microscopy (FESEM), transmission electron microscopy (TEM), thermogravimetric analysis (TGA), and contact angle measurements revealed modifications in the crystalline structure, hydrophilicity, structural arrangement, and morphology of the pristine PEI membrane by the incorporation of the CA and metal-organic framework. UV-visible spectroscopic measurements were employed to assess the membrane's capacity to adsorb Congo Red (CR) dye from water. The Ni-MOF@CA/PEI polymer nanocomposite membrane, which contained 0.5 wt% Ni-MOF, exhibited an adsorption capacity of 23.3 mg/g and a superior dye removal efficiency of 93.4%. The adsorption process was characterised by pseudo-first-order kinetics, and the experimental data were in good agreement with the Langmuir adsorption isotherm. The membrane also exhibited excellent reusability, maintaining its efficacy over multiple cycles, making it an effective adsorbent for the removal of Congo red dye.

**Keywords:** Metal-organic framework, Nanocomposite membrane, Anionic dye, Interactions, Adsorption isotherm.

**OP 97**

# ADSORPTION KINETIC, EQUILIBRIUM AND THERMODYNAMIC STUDIES FOR REMOVAL OF CONGO RED DYE FROM AQUEOUS SOLUTION USING STISHOVITE CLAY- $MnO_2$ NANOCOMPOSITE

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The removal of hazardous organic dyes from industrial effluents has become a critical environmental concern. In this study, the adsorption of Congo Red dye from aqueous solutions using stishovite clay-$MnO_2$ nanocomposites was investigated to assess the efficiency, kinetics, equilibrium, and thermodynamic properties of the process. The stishovite clay-$MnO_2$ nanocomposite was synthesized and characterized using X-ray diffraction (XRD), fourier transform infrared spectroscopy FTIR, and surface area analysis. Batch adsorption experiments were conducted under varying conditions of pH, temperature, and initial dye concentration. The adsorption data were analyzed using various kinetic models, including pseudo-first-order, pseudo-second-order, and intra-particle diffusion models, to determine the rate of adsorption. Equilibrium data were fitted to Langmuir, Freundlich, and Temkin isotherm models to evaluate the nature of the adsorption process. The results revealed that the adsorption of Congo Red followed a pseudo-second-order kinetic model, indicating a chemisorption mechanism. The Langmuir isotherm model provided the best fit for the equilibrium data, suggesting monolayer adsorption onto a homogeneous surface. Thermodynamic analysis indicated that the adsorption process was spontaneous and endothermic, with an increase in randomness at the solid-liquid interface.

**Keywords:** Adsorption, Congo red, Langmuir, Freundlich, and Temkin isotherm

**OP 98**

# FORMULATION AND QUALITY EVALUATION OF BISCUITS WITH REDUCED SUGAR AND FAT CONTENT

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Biscuits are widely consumed flour-based snack products, and their texture, appearance, and sensory qualities largely depend on the proportion of sugar and fat used in the formulation. However, reducing these components may alter the product's physical and organoleptic attributes. In this study, three biscuit varieties—cocoa biscuit, cream biscuit, and cream-and-jam biscuit—were selected for comparison. Experimental samples were formulated with reduced sugar and fat contents relative to the respective control samples. To maintain product quality, modifications to the control recipe, particularly in the levels of leavening agents, were made to ensure that the weight, thickness, length, and breadth of the trial samples closely matched those of the controls. The desired appearance and texture were achieved through the incorporation of suitable emulsifiers. Moisture content and colour parameters of the formulated biscuits were also evaluated to assess their quality attributes. The findings indicate that biscuits with reduced sugar and fat can be successfully developed without compromising key physical characteristics. Such healthier biscuit formulations may serve as a supportive dietary option for individuals seeking to manage diabetes, obesity, and related lifestyle disorders.

**Keywords:** Biscuits, sugar reduction, fat reduction, value addition, quality attributes.

**OP 99**

# A REVIEW: NUTRITIONAL AND MEDICINAL POTENTIAL OF WILD VEGETABLES FOR SUSTAINABLE DEVELOPMENT

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Wild edible vegetables contribute vital role in traditional food of India for both medicinal and traditional benefits. These underutilized plants are found in tribal region, forest and wasteland are rich source of minerals, vitamins, antioxidants and bioactive compounds. It contributes to dietary and agro diversity at the household level to medicinal properties for health improvement and sustainable life.Many species such as Bharangi, Ghol, Kurdu, Kartoli, Kavla and Korala , have demonstrated pharmacological properties including antimicrobial, antidiabetic, anti-inflammatory, antimicrobial, antidiabetic, and antioxidant activities. Thus, Wild vegetables play significant socio-economic role, despite their abundance and therapeutical potential, the importance and value of wild vegetables remain undervalued and underexplored. If these vegetables continue to be neglected, their importance and knowledge may be lost very soon which can be never be recovered. Hence there is need to create an awareness of wild vegetables, Promoting the sustainable use and conservation can support traditional medicine, and provide eco-friendly resources for nutraceutical and drug development. This review highlights the nutritional value, composition medicinal potential, and sustainable utilization strategies of wild vegetables in India, emphasizing their role in achieving health, livelihood, and biodiversity goals aligned with the principles of sustainable development.

**Keywords:** Edible, Potential, micronutrients, Nutritional ethnobotanical, ecofriendly, sustainable.

**OP 100**

# ASSESSMENT OF NUTRIENT AND MINERAL CONSTITUENTS IN BRANDED HONEY SAMPLES

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Honey is a viscous and sweet supersaturated carbohydrate solution produced by honeybees as a nutritional resource for their larvae and as a reserve food during periods of scarcity, particularly in winter. Its primary constituents are fructose, glucose, and water, although the exact proportions vary according to botanical origin. In addition, honey contains a diverse array of enzymes, volatile compounds, minerals, and other minor constituents, which together contribute to its complex chemical profile. Historically, honey has been utilized both as a dietary commodity and as a therapeutic agent. Archaeological evidence, including Stone Age rock paintings, indicates that human exploitation of honey dates back approximately 8,000 years. Beyond its long-standing role in traditional medicine, honey has been employed in the management of gastrointestinal disorders, cardiovascular conditions, inflammatory processes, and certain neoplastic diseases. Despite its extensive ethnomedicinal applications, its integration into contemporary medical practice remains limited due to insufficient scientific validation. The present study aims to investigate six commercially available honey brands with respect to their mineral content as well as the presence of carbohydrates, amino acids, and proteins. Based on the analytical assessments conducted, all honey samples were found to exhibit the expected chemical characteristics associated withthese biomolecules.

**Keywords:** pH and acidity, Moisture content, Honey composition, Commercial honey, Mineral analysis, Carbohydrate profiling,

**OP 101**

# EVALUATION OF PHYSICO-CHEMICAL PARAMETERS OF GROUNDWATER IN CUDDALORE DISTRICT, TAMIL NADU, INDIA

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This study investigates the hydro-chemical characteristics of groundwater in Cuddalore district. Groundwater samples were collected from sixty-two locations and analyzed for various physico-chemical parameters, including color, odor, pH, electrical conductivity, and total dissolved solids (TDS). Additionally, total hardness, calcium and magnesium hardness, potassium, and sulphate concentrations were determined. Ionic ratios, such as sodium to chloride, chloride to bicarbonate, and calcium to magnesium, were evaluated to assess the extent of saline water mixing with groundwater. Results indicate that most parameters exceed the permissible limits prescribed by APHA, with ionic distribution patterns revealing considerable spatial variability in groundwater quality. These variations suggest that the water is increasingly unsuitable for direct consumption. Hydro-chemical trends reflect ongoing changes driven by both natural processes and anthropogenic activities. The study provides essential baseline data for sustainable groundwater management and underscores the need for regular monitoring and treatment to ensure safe and potable water.

**Keywords:** TDS, Physico-chemical parameters, Hydro-chemical trends.

**OP 102**

# THIOPHENYL PENDENT CARDANOL END CAPPED IMINE SKELETAL NANOSILICA REINFORCED POLYBENZOXAZINE ($nCeO_2$ /PBZ-PU) NANOCOMPOSITES

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A novel Thiophenyl pendent cardinal end capped imine skeletal nanocerium oxide/polybenzoxazine polyurethane ($nCeO_2$ /PBZ-PU) nanocomposites were designed and developed via thermal polymerization. The benzoxazine monomer was obtained from Thiophenyl pendant aromatic dimine blended with formaldehyde and cardanol which then undergoes polymerization to form polybenzoxazine nanocomposites and reinforced with varying percentages of $nCeO_2$ and polyurethane. The synthesized PBZ nanocomposites were characterized by FT-IR. The PBZ nanocomposites have shown high thermal stability, glass transition temperature (Tg) and low dielectric constant. The values of dielectric constant of the nanocomposites were decreased with increased silica content. The reduction in percentage water uptake may be associated with the inherent hydrophobic nature of Ce–O–Ce network present in the $nCeO_2$ /PBZ-PU hybrid systems. The optical properties ascertained from the UV-Vis absorption bands at the region of 300–350 nm and strong emissions were observed inthe wavelength range of 300–550 nm from Photoluminescence analysis. The homogeneous morphology of the nanocomposites caused from the good interfacial interaction between the embedded $nSiO_2$ particles and PBZ nanocomposites as evidenced by SEM and AFM images.The molecular level dispersion of $nSiO_2$ particles in the polybenzoxazine matrices was evidenced from morphological studies.

**Keywords:** Cardinal, benzoxazine, nanocerium oxide, polyurethane, thermal polymerization, polybenzoxazine, nanocomposites and thermal stability.

**OP 103**

# ANTI-DIABETIC POTENTIAL OF GREEN SYNTHESIZED AgNPS USING HEPATOPANCREAS EXTRACT FROM MARINE EDIBLE CRAB *PORTUNUS PELAGICUS*

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Alpha-amylase and alpha-glucosidase enzyme inhibitors are key to reduced blood glucose levels, as anti-diabetic drugs are developed. The aim of the present study is the in vitro assessment of the anti-diabetic activity of green synthesized silver nanoparticles using hepatopancreas aqueous extract from the marine edible crab *Portunus pelagicus against* the alpha-amylase and alpha-glucosidase carbohydrate hydrolysis enzymes. The hepatopancreasof *Portunus pelagicus was* extracted with aqueous solvent using decoction methods followed by 20 minutes of boiling at 45 to 50°C, and the obtained extract was concentrated to a 1/4th ratio. The concentrated zoo extracts reduced silver ions ($Ag^{+}$) into silver atoms ($Ag^{0}$) to form silver nanoparticles (AgNPs) with initial confirmation of UV, FTIR, and SEM characterization techniques. AgNPs had a potential α-amylase and α-glucosidase inhibition ($IC_{50}$ was found to be 107.11 and 122.46 µg/mL) with a correlation statistical agreement on dose-dependent assay inhibition ($R^2$=0.9). Overall, the current finding is that the hepatopancreasof *Portunus pelagicus* mediated AgNPs had a potential anti-diabetic drug for the mode of action of inhibiting the carbohydrate hydrolysis enzyme, which responds to reduced blood glucose level. According to our knowledge, the hepatopancreas of the Portunus pelagicus crab is a remarkable source of green nanomaterial synthesis and management of type II diabetes and related hypertension.

**Keywords:** Nano-drug, AgNPs, Anti-diabetic, hepatopancreas, *Portunus pelagicus*.

**OP 104**

# ENHANCED VOLUMETRIC ETHANOL PRODUCTIVITY VIA REPEATED CELL RECYCLE BATCH FERMENTATION

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With a swift and prompt economic advantage, bioprocessing of a diverse range of feed-stocks has increased drastically in the past few decades, making process technology a major contributor in the world revenue generator within a short span of time. The strong impacts of bio-economic growth trends suggest the dependence of the nation's self-sustainment and development on bio-based alternatives and replacement of old practices by superior bioprocess technologies which would not only secure the country in itself, but will also leave a global impact.

Bio-based products/chemicals can act as a valuable answer for the profuse agricultural/cellulosic waste which is other-wise due to the lack of economically viable technologies remains inefficient for the mankind and also has significant environmental and public health hazards. Lately, because of the increase in the consumption rate of petroleum-based products and the environmental issues rising from them the bio-based platform is the prerequisite for the efficient bioconversion of lignocellulose biomass in to value added products that would lead to sustainable and economically developed nation.

In this study *Zymomonas mobilis* was used a model organism to achieve higher volumetric productivity of ethanol in repeated cell recycle batch fermentation. 60 g/L glucoses was fermented in three consecutive cycles. Ethanol yield of 0.48 g/g was achieved in all the three cycles. Maximum biomass concentrations increased from 1.33 g/L in first cycle to 3.1 g/L at the end of third cycle. Volumetric productivity of 9.63 g/L/h which was four times higher than observed in first cycle was recorded after the completion of third cycle. The study suggests repeated cell recycle fermentation as a potent strategy to achieve high cell density cultures that would decrease the fermentation time thus increasing the process productivity.

**OP 105**

# BIODEGRADABLE POLYMERIC HYDROGELS AND THIN FILMS DECORATED WITH CHARCOAL AND TRI-METALLIC NANO-COMPOSITES AND THEIR USE IN REMOVAL OF COLOUR AND TREATMENT OF INDUSTRIAL WASTE WATER IN DOMESTIC AND IRRIGATION PURPOSES

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Textile waste water containing toxic and carcinogenic dyes and effluents as by product in higher concentration which affects the marine life and creating water pollution, soil pollution. It is challenging to decolorize water and degrade dye simultaneously and remove chemicals from water. On applying several techniques color of water remains as such. After thorough literature and research, we have prepared and charterized tri-**metallic nano-composites and** combined with biodegradable polymers (ie., sodium alginate, cellulose derivatives and chitosan,) **and made their beads,sheets and membrane** for effective removal of color. Standardization of water samples were also performed by standards reported methods and further several testing is desired to put on root level.

In this art of work, we have created simulated water in chemistry lab containing higher level of impurity dyes and effluents of textile industries. Results reveals chemical treatment takes 240-420 seconds for dye degradation which remove color. The biological process takes 25-45 days using microbes*.In this art of work, we want to combine microbial and chemical treatment process and analyze the water quality standards. The treated water will be capable to reuse in domestic and irrigation purposes. Further investigations are under process.

**Keywords:** Green Chemistry, Waste water management, non-conventional energy management Nanoparticles Ag, Zn amalgam, Polymer (ESMP); template and reductant, water soluble dyes

**OP 106**

# STRUCTURAL ANALYSIS, DFT CALCULATION AND MOLECULAR DOCKING STUDIES OF BENZOTHIOPHENE DERIVATIVE

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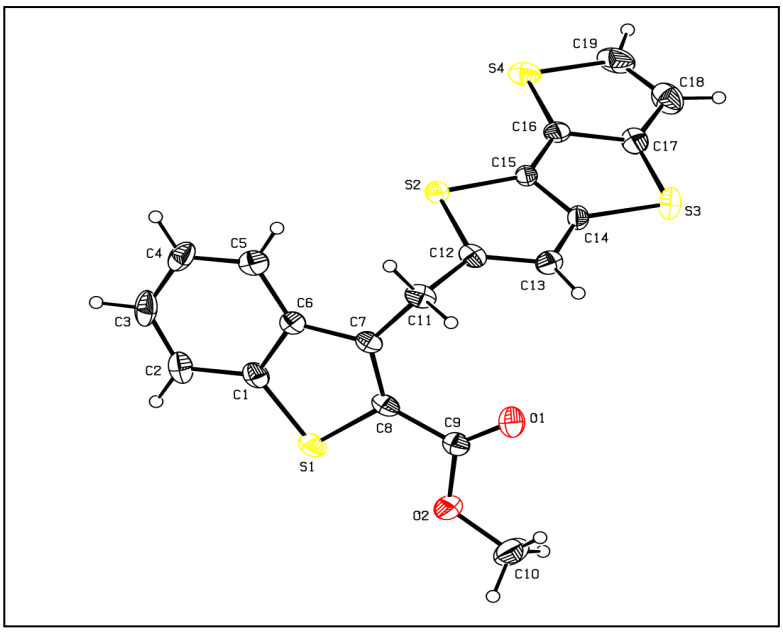
Molecules consisting of dithieno[3,2-*b*:2',3'-*d*]thiophen(DTT) framework has found a special interest because of their lower band-gap, excellent electron transport properties. Crystal structure of a benzo[b]thiophene derivative with IUPAC name, methyl 3-(dithieno[3,2-*b*:2',3'-*d*]thiophen-2-ylmethyl)-5-benzo[*b*]thiophene-2-carboxylate. The crystal structure was solved by direct methods and refined by the full-matrix least-squares procedure. The dihedral angle between DTT and benzo[b]thiophene is 71.2°. The crystal structure was stabilized by C-H…π, π…π, C-O…π interactions. DFT calculations and Molecular docking studies also supported the work.



**OP 107**

# A REVIEW ON EFFECTIVE FLUORIDE REMOVAL FROM WATER USING LOW-COST BIO-ADSORBENTS

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In India has fluoride and fluorosis issues are common in majority of places. The fluoride epidemic is spread among 19 states in India. The serious health problem occurs in human beings due to contaminated drinking water for natural and man-made action. Therefore, various treatments applied for removal of fluoride, such as Nalgonda method, contact precipitation, bone charcoal, clay column, ion-exchange, Reverse osmosis, activated alumina, and MgO. This review paper is discussed various parameters like contact time, temperature, concentration, initial fluoride, pH. From this review paper discussed various bio-adsorbents materials and also seen fluoride removal efficient.

**Keywords:** Fluoride, Bio sorbents, Toxicity and Health issues.

**OP 108**

# SUSTAINABLE SUGARCANE-BAGASSE–BASED ACTIVATED CARBON AS A HIGH-POROSITY ELECTRODE MATERIAL FOR SUPERCAPACITORS

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Sugarcane bagasse, an abundant agro-industrial waste, was converted into high-quality activated carbon through controlled carbonisation followed by KOH activation to develop a hierarchically porous structure suitable for supercapacitor applications. XRD analysis confirmed the formation of activated carbon with broad peaks at $2\theta = 23.8°$ and 43.6°, corresponding to the (002) and (100) planes. UV–Visible spectra showed a strong $\pi$–$\pi^*$ transition around 272 nm, while PL emission at ~445 nm indicated the presence of surface defects and oxygenated functional groups that enhance electrochemical activity. HRSEM micrographs revealed a highly porous morphology with interconnected channels, enabling efficient ion transport and enhanced electrolyte penetration. Electrochemical evaluation in 1 M KOH demonstrated that the material exhibits nearly ideal capacitive behaviour, achieving a specific capacitance of ~312 F $g^{-1}$ at 5 mV $s^{-1}$ from CV analysis and ~298 F $g^{-1}$ at 1 A $g^{-1}$ from GCD measurements, displaying excellent rate performance with 91% retention at higher current densities. Impedance studies further showed low internal resistance, with an ESR of 0.68 Ω and a charge-transfer resistance of 0.91 Ω, confirming superior conductivity and rapid ion diffusion. These results collectively demonstrate that sugarcane-bagasse-derived activated carbon possesses a well-developed porous framework, favourable surface chemistry, and strong electrochemical characteristics, positioning it as a promising, low-cost, and environmentally sustainable electrode material for high-performance supercapacitor devices.

**Keywords:**supercapacitor, nanocomposites, electrochemical, cyclic voltammetry

**OP 109**

# ENGINEERED $CdO@Cd_3(PO_4)_2$ MICROFLOWER HETEROSTRUCTURES VIA HYDROTHERMAL SYNTHESIS FOR SUPERIOR PHOTOCATALYTIC ACTIVITY

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This study presents the hydrothermal synthesis of cadmium oxide functionalized cadmium phosphate ($CdO@Cd_3(PO_4)_2$) nanostructures and investigates their visible-light-driven photocatalytic process. The XRD patterns confirm the formation of orthorhombic $Cd_3(PO_4)_2$ and cubic CdO, retaining the characteristic diffraction patterns of both phases without impurity peaks, indicating successful phase coexistence and high crystallinity of the $CdO@Cd_3(PO_4)_2$. Field-emission scanning electron microscopy (FESEM) images demonstrated a well-dispersed, rose-like, rod-like morphology, and energy-dispersive X-ray spectroscopy (EDS) confirmed the stoichiometric composition of Cd, P, and O. Transmission electron microscopy (TEM) of the $CdO@Cd_3(PO_4)_2$ composite confirmed its well-defined crystalline arrangement, while the corresponding SAED patterns revealed distinct ring diffraction features indicative of a polycrystalline structure. The 3 wt.% $CdO@Cd_3(PO_4)_2$ composite achieved a remarkable photocatalytic efficiency of 99.2% under visible-light irradiation, completely degrading Rhodamine B within 120 minutes and thereby confirming its strong potential as an effective semiconductor photocatalyst. The $CdO@Cd_3(PO_4)_2$ nanostructures demonstrated significantly enhanced photocatalytic activity at neutral pH, attributed to improved surface charge distribution and efficient heterojunction-driven charge separation. The 3 wt.% $CdO@Cd_3(PO_4)_2$ photocatalyst maintained >90% degradation efficiency over 5 cycles, confirming excellent stability and resistance to photocorrosion. It shows that the $CdO@Cd_3(PO_4)_2$ is a promising photocatalyst for environmental applications, including dye degradation and wastewater purification.

**OP 110**

# SYNTHESIS AND CHARACTERIZATION OF CdS-$TiO_2$ MATERIALS AND THEIR APPLICATIONS

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Cadmium sulfide–titanium dioxide (CdS–$TiO_2$ ) composite materials have emerged as highly attractive semiconductor systems for photocatalytic and optoelectronic applications due to their complementary optical band gaps, efficient charge separation behavior, and tunable nanostructures. $TiO_2$ , a robust wide-band-gap semiconductor (Eg ≈ 3.0–3.2 eV), exhibits high chemical stability, non-toxicity, and excellent photocatalytic activity under UV illumination; however, its practical utility is restricted by limited absorption of visible light and rapid electron–hole recombination. In contrast, CdS, with a narrow band gap of 2.3–2.4 eV, effectively absorbs visible light but suffers from photo corrosion and limited stability. Integrating CdS with $TiO_2$ offers a synergistic strategy to overcome the individual shortcomings of each material by forming heterojunctions that facilitate directional charge transfer, broaden the spectral response, and enhance photocatalytic efficiencies.

Comprehensive characterization of CdS–$TiO_2$ systems is carried out using complementary spectroscopic, microscopic, and electrochemical techniques. Powder X-ray diffraction (XRD) confirms the formation of crystalline anatase/rutile $TiO_2$ and hexagonal CdS phases, as well as verifying heterojunction formation. UV–Vis diffuse reflectance spectroscopy reveals extended visible-light absorption and reduced band-gap energies compared to pristine $TiO_2$ . Photoluminescence (PL) spectroscopy provides information on recombination kinetics, with reduced PL intensity indicating suppressed electron–hole recombination.

Electron microscopy techniques (SEM and TEM) offer insights into surface morphology, particle size distribution, and the spatial arrangement of CdS on $TiO_2$ surfaces. Additionally, X-ray photoelectron spectroscopy (XPS) is used to analyze the chemical states and interfacial bonding environment. Electrochemical impedance spectroscopy (EIS), transient photocurrent studies, and Mott–Schottky analyses further support improved charge separation efficiencies and favorable band alignment in the composite.

**OP 111**

# ADVANCES IN MAGNETO-RESPONSIVE HEUSLER ALLOYS: MULTIFUNCTIONAL PLATFORMS FOR SMART ACTUATION, THERMAL MANAGEMENT AND BIOMEDICAL HEATING

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Heusler alloys which were first identified in the early twentieth century and now regarded as one of the most versatile classes of smart materials have evolved into key candidates for a wide spectrum of functional technologies, ranging from adaptive devices and spintronic components to solid-state magnetic refrigeration systems. Their remarkable performance stems from a cooperative interplay between structural and magnetic degrees of freedom, which gives rise to a suite of magneto-functional transitions, including the shape-memory effect, giant magnetocaloric effect, pronounced magnetoresistance and characteristic ferro–antiferromagnetic interactions. Among them, Ni–Mn-based Heusler systems have attracted sustained research interest due to the strong sensitivity of their magneto-structural transitions to compositional tuning, elemental substitution and controlled disorder. These alloys can undergo rapid, field-driven reversible deformation, enabling actuation responses that are inherently faster and more efficient than thermally induced mechanisms. Recent investigations on Ni–Mn–Cu–Ga compositions further demonstrate the promise of finely engineered particles exhibiting sharp and reversible martensitic transformations, positioning them as effective self-regulating agents for magnetic hyperthermia. Collectively, these developments reaffirm the central role of Heusler alloys as multifunctional smart materials capable of supporting next-generation actuation, cooling, sensing and biomedical technologies.

**Key words:** Heusler alloys, shape-memory effect, magnetic hyperthermia, magnetocaloric effect, smart materials.

**OP 112**

# ANTI-MITOTIC AND ANTI-PROLIFERATIVE POTENTIAL OF ZOO-SYNTHESIZED AUNPS: AS A GOLD ION REDUCING AGENT OF ZOOCHEMICAL EXTRACT OF HEPATOPANCREAS FROM *SCYLLA SERRATA*

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In this study, the anti-cancer properties of green synthesized gold nanoparticles (AuNPs), using zoochemical extract of hepatopancreas from *Scylla serrata*, were assessed in the *in vitro* cytotoxicity (anti-proliferative) model of yeast cell *Saccharomyces cerevisiae* toxicity and the anti-mitotic model through the root tip inhibition and mitotic index on *Allium cepa*. Hepatopancreas extract with deionized water at 45 to 50°C and concentrated to a $1/4^{th}$ ratio. A zoochemical extract of hepatopancreas from *S. serrata* was reduced by gold ion ($Au^{3+}$ ) into gold atoms ($Au^{0}$ ), which formed gold nanoparticles (AuNPs) with confirmation of UV, FTIR, and SEM characterization techniques. Zoochemical-mediated AuNPs (Z-AuNPs) had potential anti-proliferative ($EC_{50}$ = 95.43 µg/mL for yeast assay) and anti-mitotic (mitotic index = 24.35±3.56% at 250 µg/mL) properties, with an exhibited dose-dependent manner ($R^2$=0.9) that agreed with the correlation statistic. Current findings of Z-AuNPs suggesting its potential as a cytotoxicity and anti-mitotic agent confirmed it to be reducing yeast cell viability and *Allium cepa* root tip growth, while significant mitotic abnormalities, such as prophase accumulation, sticky chromosomes, spindle disruption, and anaphase bridges, were observed. Overall, hepatopancreas extract of the marine crab *S. serrata* is a remarkable source of green nanotechnology and anti-cancer applications, which significantly contribute to the presence of bioactive zoochemicals supporting gold nanoparticle synthesis and anticancer agents. According to our knowledge, confirmation of nano-anticancer drug development of Z-AuNPs needs *in vivo* (preclinical and clinical) experiments.

**Keywords:**Nano drug, Anti-mitotic, Anti-proliferative, Zoo-synthesis, Hepatopancreas, *Scylla serrata*

**OP 113**

# PERFORMANCE INVESTIGATION WITH EXPERIMENTAL TESTING OF CONCRETE WITH RECYCLED COARSE AGGREGATE AND FRP WASTE AS FINE AGGREGATE

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Concrete being the most important and widely used construction material in the world has been used from many decades, meaning that a tremendous quantity is utilized and also have to continue using it. The concrete uses up large quantities of natural resources and creates an impact on environment because of the debris created by the demolition waste which is being generally discarded in landfills. The basic ingredients of concrete are cement, fine aggregates, coarse aggregates and water. The major fraction of concrete utilizes the coarse aggregates i.e., nearly 65% of the concrete is made up of coarse aggregates. The production of aggregates which are naturally occurring resources requires mining from the quarries resulting in the depletion of resources at a rapid pace.

The present work focus on the usage of Recycled Coarse Aggregates (RCA) in concrete along with FRP Waste as Fine Aggregate. The study includes the effects of replacement of Natural Corse aggregates by Recycled aggregates in percentages of 0, 25 and 50 along with 0, 25 and 50 percentage of FRP Waste as Fine Aggregate at room temperature.

The experimental investigation presents the mechanical properties such as compressive strength, Split tensile strength and modulus of Elasticity along with the Non-destructive tests such as Rebound Hammer and Ultrasonic Pulse Velocity.

**OP 114**

# SUSTAINABLE ONE-POT FABRICATION OF NITROGEN-ENRICHED CARBON NANOFERTILIZERS FROM PAPAYA WASTE AND THEIR BIOEFFICACY ON EGGPLANT DEVELOPMENT

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This work introduces an environmentally sustainable strategy for synthesizing nitrogen-enriched carbon nanofertilizers (N-CNFs) utilizing papaya peel extract, a valorised agro-waste resource. The nanomaterials were generated via a single-pot process, employing dextrose as a carbon precursor and urea as a nitrogen donor, while inherent phytochemicals in the extract functioned simultaneously as reducing and stabilizing agents. Structural analyses verified the incorporation of nitrogen and oxygen functionalities within the carbon matrix, producing uniformly distributed nanoparticles with sizes ranging from 30 to 49 nm.

The agricultural potential of the synthesized N-CNFs was evaluated using eggplant (Solanum melongena L.), focusing on germination and early vegetative growth. Seeds treated with N-CNFs achieved a superior germination rate of 98.4% by the seventh day, alongside enhanced shoot elongation and seedling Vigor compared to untreated and conventionally fertilized controls. Treated plants exhibited marked increases in chlorophyll content, leaf proliferation, biomass accumulation, and earlier onset of flowering. Antioxidant assessment highlighted strong free-radical scavenging capacity, reflected by an $IC_{50}$ value of 40.19 µg/mL. Microscopic examination confirmed nanoparticle internalization within plant tissues, suggesting improved nutrient uptake efficiency and metabolic stimulation, underscoring the promise of N-CNFs as green biofertilizers in sustainable agriculture.

**OP 115**

# NANO-ENABLED LACCASE: A POWERFUL TOOL FOR INDUSTRIAL EFFLUENT CLEANUP

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The rapid expansion of the global pharmaceutical sector, including India's USD 50-billion industry, has contributed significantly to rising levels of pharmaceutical contaminants in aquatic ecosystems. More than 700 active pharmaceutical ingredients have now been detected in rivers, lakes, and groundwater, posing severe ecological risks and accelerating the emergence of antibiotic-resistant bacteria. Conventional physicochemical approaches (coagulation, activated sludge treatment, and membrane filtration) often fail to completely remove recalcitrant pharmaceuticals designed for biological stability. Consequently, advanced materials-based solutions, particularly nanoparticle-reinforced enzymatic systems, have gained considerable attention as a sustainable alternative for treating pharmaceutical wastewater.

Laccase nanoparticles are especially promising due to their broad substrate specificity, cofactor-independent oxidation using oxygen, and compatibility with magnetic, photocatalytic, and MOF based nanomaterials. When integrated into nanoparticle systems, laccase demonstrates enhanced degradation of persistent drug residues, improved resistance to inhibitors found in complex effluents, and greater operational stability. This positions laccase-nanoparticle hybrids as a greener alternative to chemical oxidants, with strong potential for addressing antibiotics, analgesics, steroidal hormones, and emerging contaminants.

Despite their advantages, significant research gaps remain including limited industrial scale demonstrations, insufficient long term stability data, and incomplete understanding of degradation pathways. This work addresses these gaps by extracting and characterizing plant-derived laccase, synthesizing stable laccase nanoparticles, and evaluating their catalytic performance against major pharmaceutical pollutants under varying environmental conditions.

**OP 116**

# EXPLORING ELECTRON SPIN RESONANCE STUDY OF PEPTIZED $TiO_2$ : INFLUENCE OF TiO2 WEIGHT%, $H^+$ /Ti MOLE RATIO, PEPTIZATION TEMPERATURE, AND SOLVENT

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Peptization critically controls the physicochemical properties of $TiO_2$ sols by determining particle size, defect concentration, and surface electronic structure. In this study, Electron Spin Resonance (ESR) spectroscopy analyzed paramagnetic defect centers generated in $TiO_2$ peptized under systematically varied conditions: $H^+$ /Ti mole ratio, peptization temperature, and solvent environment. ESR spectra revealed that primary signals arose from $Ti^{3+}$ centers and oxygen vacancy-related defect species. Increased $H^+$ /Ti ratios enhanced particle dispersion and reduced ESR-active surface defects. Conversely, elevated peptization temperatures promoted $Ti^{3+}$ center formation through thermal dehydration and partial reduction processes. Variations in solvent polarity and coordinating ability significantly influenced defect stabilization. These findings demonstrate ESR's sensitivity for probing structural and electronic changes in $TiO_2$ during colloidal processing.

**Keywords:** $TiO_2$ peptization, ESR Study, TiO2 Weight%, $H^+$ /Ti Mole Ratio, Peptization Temperature

**OP117**

# EFFECT OF HIGH-TEMPERATURE AND PRESSURE SYNTHESIS ON THE STRUCTURAL PHASE TRANSITION OF CITRIC ACID–CAPPED CdS

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This study investigates how high-temperature and high-pressure hydrothermal synthesis influences the structural transformation of citric acid–capped cadmium sulfide (CdS) nanocrystals from the thermodynamically stable hexagonal wurtzite phase to the metastable cubic zinc blende phase. Using controlled temperatures (120–220 °C) and autogenous pressure conditions, we demonstrate that citric acid coordination, combined with hydrothermal reaction environments, significantly alters nucleation growth kinetics, stabilizes surface energies, and drives size- and ligand-mediated phase transitions. We examined structural evolution through XRD, Raman spectroscopy, HRTEM, and FTIR analysis. Results indicate that higher temperatures (>180 °C) and elevated pressures facilitate dissolution reprecipitation cycles, modify citrate–Cd(II) chelation strength, and reduce anisotropic growth, ultimately promoting the cubic phase. This work provides mechanistic insights into hydrothermal ligand-controlled phase tuning, offering pathways for engineering phase-specific CdS nanostructures for optoelectronic, photocatalytic, and sensing applications.

**Keywords:** CdS nanocrystals, Citric acid–capping, High Temperature, high Pressure, Phase transition

**OP 118**

# SELF-HEALING CHITOSAN–SILVER NANOCOMPOSITE FOR SUSTAINABLE METHYLENE BLUE DEGRADATION AND WATER PURIFICATION

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This work presents a self-healing polymer nanocomposite designed to restore mechanical strength and catalytic activity after damage. The material uses a chitosan matrix integrated with silver nanoparticles synthesized in situ to enable crack reformation, enhanced surface binding, and efficient dye degradation. Structural analysis using FTIR, XRD, and SEM confirms nanoparticle dispersion and bond interactions. The composite achieved ~92% degradation of methylene blue within 120 minutes under visible light, following first-order kinetics. Mechanical recovery reached ~85% after repeated damage-healing cycles, with over 78% catalytic efficiency retained after five regeneration cycles. The material offers a renewable, low-impact approach for long-term water purification and environmental remediation.

**Keywords:** Chitosan, Silver nanoparticles, Self-healing materials, Methylene blue degradation, Water purification.

**OP 119**

# IN SILICO APPROACH ON SELECTIVE BIOACTIVE COMPOUNDS IDENTIFIED FROM CATHARANTHUS ROSEUS LEAVES AGAINST P38MITOGEN-ACTIVATED PROTEIN KINASE (P38 MAPK) AND C-JUN AMINO TERMINAL KINASE (JNK)

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In silico approach is one of the most powerful techniques to discover novel ligand for proteins of known structure and thus play key role in structure-based drug discovery. Hence, the purpose of the present study was to perform an in silico docking of nephroprotective properties of phytocompounds identified from *Cathranthus roseus* leaves namely Octadecanoic acid, Methyl ester, 9-Octadecenoic acid, 9,12-Octadecadienoyl chloride and Hexadecanoic acid against p38 mitogen-activated protein kinase (p38 MAPK) and c-Jun amino terminal kinase (JNK) using Autodock software. Present study concluded that the selected bioactive compounds can efficiently bind to the receptors and molecular docking can be successfully used in finding p38 mitogen-activated protein kinase (p38 MAPK) and c-Jun amino terminal kinase (JNK) inhibitors. Among the various compounds, 9,12-Octadecadienoyl chloride and 9-Octadecenoic acid has potential binding interactions than other compounds. Hence, the studied bioactive compounds have the potential and may be used as nephroprotective agents against kidney diseases. However, these results are only preliminary screening just to facilitate subsequent in vitro and in vivo studies and thus warrants further investigation. To the best of our knowledge, this is the first report that bioactive compounds from hydro-ethanolic extract of *Cathranthus roseus* are subjected to molecular docking for screening for their nephroprotective potentials.

**Keywords:** *Cathranthus roseus* leaves extract; Docking; Bioactive compounds; p38 MAPK; JNK; Autodock.

**OP 120**

# SYNTHESIS ZINC OXIDE NANOPARTICLES USING CYNODON DACTYLON AND ASSESSMENT OF THEIR BIOLOGICAL ACTIVITY STUDIES

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Green nanotechnology offers an eco-friendly approach for producing functional nanomaterials with diverse biomedical applications. In the present study, zinc oxide nanoparticles (ZnO NPs) were synthesized using the aqueous extract of Cynodon dactylon, which served as a natural reducing and stabilizing agent. The formation of ZnO NPs was confirmed by their characteristic optical and structural features obtained from UV–Visible spectroscopy, X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), and electron microscopy analyses. These results indicated the successful fabrication of crystalline, phytochemical-capped ZnO NPs with nanoscale dimensions and stable morphology. The biological potential of the synthesized nanoparticles was evaluated through antimicrobial, antioxidant, and cytotoxicity assessments. The ZnO NPs exhibited notable antimicrobial activity against selected bacterial strains, enhanced radical-scavenging capacity in chemical antioxidant assays, and a dose-dependent cytotoxic effect in preliminary cell-compatibility evaluations. Overall, the study demonstrates that Cynodon dactylon-mediated green synthesis is an efficient route for producing bioactive ZnO nanoparticles, highlighting their potential applications in pharmaceutical, biomedical, and environmental fields.

**Keywords:** Cynodon dactylon, ZnO nanoparticles, Photochemical-capped, antimicrobial activity.

**PP 01**

# MACHINE LEARNING-DRIVEN DESIGN OF 2D NANOMATERIALS: EXPLORING ZnO-DOPED SYSTEMS AND DEEP LEARNING APPLICATIONS

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Machine learning integration with materials science has revolutionized the design and synthesis of two-dimensional (2D) zinc oxide (ZnO)-doped nanomaterials. This study examines the feasibility of creating novel 2D nanomaterials using artificial intelligence-driven approaches. Machine learning techniques, particularly graph neural networks (GNNs) and convolutional neural networks (CNNs), have demonstrated remarkable success in materials discovery, identifying over 2.2 million new stable crystal structures. For ZnO-based systems, machine learning models achieved exceptional accuracy in predicting nanoparticle synthesis outcomes, with root mean square errors as low as 0.84%. Computational studies confirm that 2D ZnO monolayers can be successfully doped with various elements, achieving up to 99% optical transparency while maintaining excellent electrical conductivity. Current research demonstrates strong feasibility for machine learning-guided 2D materials design, supported by established computational infrastructure and comprehensive materials databases. The analysis identified ambiguity regarding "PEP" as a dopant in ZnO systems, revealing potential interpretations including peptide-enhanced processing or polymer-based systems.

The convergence of artificial intelligence and materials science enables accelerated discovery of functional 2D nanomaterials. Future research should prioritize database development, multi-scale modelling integration, and automated synthesis platforms. This work establishes a foundation for next-generation materials design approaches that could revolutionize optoelectronic, catalytic, and biomedical applications through precisely engineered 2D nanomaterials.

**Keywords:** Machine Learning, ZnO NP's, Conventional Neural Network, Graphical Neural Network.

**PP 02**

# MACHINE LEARNING BASED EARLY DETECTION OF BREAST CANCER

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Breast cancer diagnosis and treatment monitoring increasingly rely on rapid, minimally invasive biomarker assessment. This project presents the development of a novel multiplex electrochemical biosensor strip, integrated with an optical reader and machine-learning analytics, designed for point-of-care detection of key breast cancer biomarkers. A panel consisting of HER2, CA15-3, CEA, and MMP-9 (with potential extension to EGFR and microRNAs) was selected based on their clinical relevance in early detection, tumour burden assessment, and metastasis monitoring. Each biomarker-specific working electrode is fabricated on a screen-printed PET-based three-electrode system, using gold or carbon conductive inks, Ag/AgCl reference ink, and carbon counter electrodes. Antibodies are immobilized via SAM formation and EDC/NHS coupling chemistry, followed by BSA blocking to minimize non-specific interactions. The integrated reader communicates with a mobile application via USB, converting raw fluorescence intensity into biomarker concentrations using pre-stored calibration curves and internal quality-control validation. To enhance clinical decision-making, biomarker measurements are further processed using machine-learning models (Logistic Regression, Random Forest), trained on labelled datasets across healthy individuals and cancer stages I–IV. The model incorporates metadata (age, temperature, strip lot, device ID) and applies preprocessing steps such as normalization, batch correction, and derived feature generation. Performance is evaluated using sensitivity, specificity, F1-score, ROC-AUC, PPV/NPV, and multiclass metrics. The proposed system offers significant potential as a point-of-care screening and monitoring tool for breast cancer, supporting early intervention, personalized treatment planning, and resource-limited clinical settings.

**PP 03**

# GREEN SYNTHESIS OF CERIUM DOPED BISMUTH OXIDE NANOPARTICLES AND INVESTIGATION OF THEIR ANTIBACTERIAL, LARVICIDAL AND PHOTOCATALYTIC ACTIVITY

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The current study reports an eco-friendly green synthesis of Ce-doped $Bi_2O_3$ nanoparticles (NPs) using the aqueous extract of *coldenia procumbens* leaves as the reducing agent. The synthesized Ce-doped bismuth oxide was characterized using (UV-vis) spectroscopy, FT-IR, XRD, HR-SEM, and TEM EDAX techniques. UV-visible spectra showed an absorbance peak in the region 502-512 nm. Fourier Transform Infrared Spectrometer(FT-IR) analysis was carried out to determine the nature of the capping agents in the leaf extract. Furthermore, the functional group in the prepared samples was confirmed by FT-IR analysis. Surface morphology was evaluated with Scanning Electron Microscopy and TEM. The band gap of green synthesized Ce-doped $Bi_2O_3$ was found to be 1% 2.5 eV, 10% 2.3 Ev. Antibacterial activity of Ce-doped $Bi_2O_3$ was found against various strains such as *E. coli, K. pneumonia* (Gram-negative) and *E.faecalis, and S. aureus* (Gram-positive) by Disc Diffusion method. The synthesized nanoparticles showed good anti-larvicidal activity against mosquito larvae such as *A.aegypti* and *A.albopictus*. The photocatalytic activity of Ce- BiONPs was studied using Malachite green (MG) and Methylene Blue (MB) dye. The synthesized nanoparticle showed 81 % and 90% degradation of MG and MB dyes, respectively. The synthesized (Ce-BiONPs) can be an excellent candidate for Environmental remedies.

**Keywords:** Cerium nanoparticles, *Coldenia procumbens* Linn., Biological activities. Photocatalytic activity, Metal oxide nanoparticles.

**PP 04**

# A NOVEL PEI–GO/LDH TERNARY COMPOSITE MEMBRANE FOR FFICIENT ADSORPTIVE REMOVAL OF ORGANIC DYES FROM WASTEWATER

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The discharge of persistent organic dyes from industrial waste poses a serious threat to both environmental and human health concerns, as these organic pollutants are highly toxic, non-biodegradable, and resistant to conventional treatments. Polymeric membranes incorporated with nanofillers offer a promising and efficient route to remove industrial dyes from wastewater. In this research work, Polyetherimide was modified using layered double hydroxide/graphene oxide to form a single-polymer matrix membrane, which was evaluated for the adsorptive remediation of industrial organic dyes. PEI provides mechanical and chemical stability within the matrix, while LDH improves the anionic and cationic exchange sites and improves the compatibility of the matrix. The incorporation of GO into the matrix paves the way for enhanced high surface area, oxygenated functional groups, which increase the adsorption pathways. The resulting PEI-LDH /GO were characterized for morphology, thermal stability, mechanical properties and dye removal efficiency for both anionic and cationic dyes. The hybrid polymer matrix exhibited significant adsorption capacity and improved dye adsorption compared to pristine PEI, which was attributed high synergistic interplay between LDH and GO within the polymer matrix. Additionally, the polymer membrane demonstrated good reusability and regeneration ability over multiple adsorption-desorption cycles, which indicates its potential as a sustainable and cost-effective membrane for wastewater treatment. In conclusion, this study highlights the rational design of PEI-LDH/GO mixed matrix membrane as an efficient and eco-friendly platform for enhanced dye removal from wastewater.

**Keywords:** Layered double hydroxide, Graphene oxide, Waste water treatment

**PP 05**

# Fe-HNT@PVP/PEI MEMBRANES: DEVELOPMENT AND ENHANCEMENT FOR EFFECTIVE DYE ELIMINATION AND WATER PURIFICATION

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This study envisages the improvement in adsorption efficiency of polyetherimide (PEI) membranes by integrating Fe-doped halloysite nanotubes (Fe-HNTs) into polyvinylpyrrolidone (PVP)-modified PEI matrices for reducing water contamination caused by dyes, which are known for their harmful impact on aquatic life. Fe-HNTs were synthesized via Co-precipitation method and incorporated into PEI/PVP membranes at 1% and 2% concentrations by utilising simple, non-destructive phase inversion technique. The modification of polyetherimide matrix by PVP/ Fe-HNTs brought significant structural alterations, improved hydrophilicity, and morphological changes in the membranes. These changes were witnessed through techniques including Fourier Transform Infra-Red, X-Ray diffraction, Xray Photoelectron Spectroscopy, contact angle measurements, Scanning Electron Microscopy and Atomic Force Microscopy. The 2%-Fe-HNTs@PVP/PEI membrane demonstrated superior adsorption capacity for methylene blue (MB) dye, with significantly enhanced removal efficiency compared to the unmodified PVP/PEI membrane. Kinetic studies revealed a fast adsorption rate, fitting with pseudo-first-order and Langmuir isotherm models. The membrane also exhibited excellent reusability, maintaining its efficacy over multiple cycles. In textile effluent treatment trials, the modified membrane achieved an impressive 85% removal of dye pollutants within 300 min, underscoring its appropriateness for environmental remediation and purification of water.

**Keywords:** Fe-doped halloysite nanotubes, PVP/PEI membranes, Adsorption, Cationic and anionic dye, Water treatment, Membrane porosity.

**PP 06**

# ENGINEERING NOBLE METAL COATINGS ON BIMETAL PHOSPHIDE FOR ENHANCED HYDROGEN EVOLUTION REACTION

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Designing highly active and durable electrocatalysts is crucial for achieving efficient hydrogen evolution in alkaline media. In this work, an Ag-coated nickel–cobalt phosphide (Ag–NiCoP) catalyst was synthesized through a simple one-pot hydrothermal method followed by silver ions deposition. The incorporation of Ag significantly enhanced the electrical conductivity and accelerated charge transfer, while also providing additional catalytic interfaces that facilitated hydrogen adsorption and desorption.

Structural and morphological characterizations confirmed the successful formation of crystalline NiCoP with uniformly distributed Ag nanoparticles. Electrochemical measurements demonstrated that the Ag–NiCoP catalyst exhibited excellent hydrogen evolution reaction (HER) activity in alkaline medium, achieving a lower overpotential 130 mV and smaller Tafel slope compared to pristine NiCoP. The enhanced catalytic performance is attributed to the synergistic effect between Ag and NiCoP, which collectively improve electron transport, optimize hydrogen adsorption energy, and increase the number of accessible active sites. This study presents a facile and effective hydrothermal approach to develop Ag-modified NiCoP catalysts for efficient and sustainable hydrogen production.

**PP 07**

# 2D MXenes SUPPORTED BIMETAL PHOSPHIDE ELECTROCATALYST FOR HYDROGEN EVOLUTION REACTION

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Efficient and durable electrocatalysts are essential for promoting the hydrogen evolution reaction (HER) in water electrolysis. In this work, a NiCo phosphide (NiCoP)/MXenes composite was successfully synthesized by integrating hydrothermally prepared NiCoP with MXenes obtained through selective etching of the MAX phase. The two components were uniformly mixed and ultrasonically dispersed to ensure intimate interfacial contact, forming a stable hybrid structure. Electrochemical measurements reveal superior catalytic activity compared to pristine NiCoP, exhibiting a low overpotential of 150 mV for the hydrogen evolution reaction (HER), along with a small Tafel slope, indicating rapid reaction kinetics. The NiCoP/MXenes composite also demonstrates excellent durability and structural stability during long-term operation. These results highlight the synergistic coupling effect between NiCoP and MXenes, offering a promising route for designing advanced bifunctional catalysts for overall water splitting and other sustainable energy conversion technologies.

**PP 08**

# ELECTROCHEMICALLY $WO_3$ DOPED ZnSe ENHANCED TO THEELECTROCHEMICAL PERFORMANCE OF SUPERCAPACITOR

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Cost-effective and stable electrode materials are vital for advancing supercapacitor technologies. Here, we report a hydrothermally synthesized WO3/ZnSe heterostructure that exhibits significantly enhanced electrochemical charge storage. Structural and morphological analyses (XRD, FE-SEM) confirm the coexistence of monoclinic WO3 and cubic ZnSe phases with a well-integrated heterointerface. Electrochemical testing in a three-electrode configuration (Ag/AgCl reference, Pt counter, 2 M KOH) reveals a high specific capacitance of 462.2 F g−1 at 1 A g−1, together with excellent cycling stability of ~90% retention after 1000 cycles. Impedance spectroscopy and charge-discharge analyses further demonstrate reduced resistance, efficient charge transport, and improved ion diffusion within the heterostructure. These findings highlight WO3/ZnSe as a promising, low-cost electrode material for high-performance supercapacitors. Key Words: WO3/ZnSe heterostructure, Supercapacitors, Hydrothermal synthesis, Specific capacitance and Cycling stability.

**Keywords:** $WO_3$/ZnSe heterostructure, Supercapacitors, Hydrothermal synthesis, Specific capacitance and Cycling stability.

**PP 09**

# REVOLUTIONIZING WEARABLE TECHNOLOGY: A REVIEW OF NANOMATERIALS FOR FLEXIBLE ELECTRONICS

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Flexible and wearable electronics are rapidly reshaping modern technology by offering devices that are lightweight, comfortable, and capable of adapting to the movement and shape of the human body. A significant factor in their expansion has been the development of cutting-edge Nanomaterial, which offers properties like mechanical strength, conductivity, and flexibility that are lacking in more conventional electronic components. This review brings together the major classes of Nanomaterial such as graphene, carbon nanotubes, metal Nanowires, metal oxides, two-dimensional semiconductors, conducting polymers, and hybrid nanocomposites and explains how their unique properties enable the development of high-performance wearable devices. It also emphasizes the fabrication techniques such as electro spinning, 3D printing, vapor-phase processes, and printing methods that make these materials compatible with flexible substrate. The wide range of applications supported by these Nanomaterials, from wearable sensors and flexible displays to energy storage and self-powered systems, is discussed to illustrate their growing significance in real-world technologies. Current challenges related to durability, large-scale production, biocompatibility, and long-term performance are examined, along with emerging opportunities such as self-healing materials, environmentally friendly synthesis, and AI-assisted material design. Overall, this review underscores the transformative role of Nanomaterial in shaping the next generation of intelligent, sustainable, and human-centric wearable electronics.

**Keywords:** Nanomaterial, Flexible Electronics, Wearable Devices, Graphene, Carbon Nanotubes, Energy Harvesting, Smart Materials, Stretchable Sensors

**PP 10**

# THERMOCHROMIC HYDROGEL BANDAGE FOR RAPID VISUAL DETECTION OF WOUND INFECTION

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Wound infections remain a persistent healthcare concern, requiring rapid and reliable diagnostic strategies to prevent complications. This study investigates the design and characterization of a thermochromic hydrogel system capable of visual detection of infection-induced temperature variations. The hydrogel is synthesized from a sodium alginate–gelatine hybrid matrix, incorporating encapsulated thermochromic microcapsules and an optional pH-responsive dye for dual-sensing capability. Crosslinking with calcium ions enhances mechanical stability while preserving porosity and biocompatibility. The material exhibits a distinct and reversible color transition in the temperature range of 30–42 °C, aligning with physiologically relevant changes during inflammation. Comprehensive evaluations were performed to analyse mechanical strength, swelling behavior, thermal responsiveness, and cytocompatibility using fibroblast cell lines. The correlation between colorimetric shift and infection-simulated conditions was validated using *Staphylococcus aureus* and *Escherichia coli* cultures. Additionally, a smartphone-assisted photo-analysis method is proposed for quantitative assessment of the thermal response, supporting potential integration into remote monitoring and telemedicine platforms. The results demonstrate that this biodegradable, non-toxic, and cost-effective thermochromic hydrogel offers a sustainable approach for early infection detection and aligns with the development of eco-conscious smart biomedical materials.

**Keywords:**Thermochromic hydrogel, wound infection detection, sodium alginate, gelatine, smart materials, colorimetric sensing, biocompatibility.

**PP 11**

# HYBRID CNN–TRANSFORMER ARCHITECTURE FOR AUTOMATED DIABETIC RETINOPATHY DETECTION AND GRADING

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Diabetic Retinopathy (DR) is a progressive ocular disease and a major cause of vision loss worldwide, necessitating early and accurate diagnosis. Traditional diagnostic methods rely on manual fundus examination, which is time-consuming and prone to variability. To address these challenges, this study proposes a hybrid Convolutional Neural Network (CNN) and Vision Transformer (ViT) framework for automated detection and severity grading of diabetic retinopathy from retinal fundus images. The CNN backbone, based on EfficientNet-B4, extracts local spatial and textural features, while the Transformer encoder models global dependencies across retinal regions, enabling the network to capture both micro-level lesions and macro-level structural variations. The proposed hybrid model is trained on the Eyepacs and APTOS 2019 datasets with advanced preprocessing techniques, including illumination correction and contrast-limited adaptive histogram equalization (CLAHE). Experimental results demonstrate superior accuracy, sensitivity, and ROC-AUC compared to standalone CNN or Transformer models. Furthermore, Grad-CAM and attention map visualizations enhance interpretability by highlighting clinically relevant regions. The final model is deployed as a scalable cloud-based diagnostic service on AWS SageMaker, showcasing its potential for real-world tele-ophthalmology applications. This work demonstrates that CNN–Transformer hybrid architectures can provide both high diagnostic accuracy and transparency, making them valuable tools for early diabetic retinopathy screening.

**Keywords:**Convolutional Neural Networks (CNN), Vision Transformers (ViT), Diabetic Retinopathy, Fundus Imaging, Deep Learning, Explainable AI, Hybrid Models, AWS SageMaker

**PP 12**

# MICROPLASTIC CONTAMINATION IN AQUATIC SYSTEMS: ORIGINS, DETECTION TECHNIQUES AND POLYMER MEMBRANE-BASED REMOVAL METHODS

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Microplastic (MP) contamination has become a significant ecological issue in the aquatic environment due to the high use of plastic and inadequate management of plastic waste. MPs originating from the effluents of different industries, as well as wastewater and drinking water treatment plants. Their tiny size, chemical diversity, and ability to carry hazardous contaminants and microorganisms pose a potential risk to the entire aquatic environment. Conventional water treatment systems are highly ineffective for removing MPs from water, which has led to the development of advanced removal techniques for MP removal in water. Polymer membrane-based MP removal caught the attention of researchers due to the tunable pore size, high selectivity, mechanical strength, and ease of surface modification. Commercially available PVDF, PES, and PTFE-based polymer membranes showed over 90% MP removal efficiency in water. Recent research progress in biopolymer membranes, mixed-matrix membranes (MMMs), and electrospun nanofibrous membranes (ENMs) has further enhanced removal performance and also improved hydrophilicity and antifouling properties of the polymer membranes. This review summarises an overview of MP origins, detection methods, and advances in polymer-membrane-based removal strategies, highlighting current challenges and prospects for large-scale applications.

**Keywords:**Microplastic origin and detection, Microplastic removal, Mixed matrix membrane, Polymer membrane, Water treatment.

**PP 13**

# SYNTHESIS, CHARACTERISATION AND APPLICATION OF ZEROVALENT IRON NANO PARITICLES FOR REMOVAL OF TECHNITIUM FROM RADIOACTIVE LIQUID WASTE

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Technetium-99 a fission product of uranium-235 is significant due to its long half-life (t1/2 = 2.13x10- 5 yr with beta energy of 0.297 Mev), abundance in nuclear wastes. Pertechnetate, TcO4- is the most stable form of technetium under aerobic conditions and it is highly soluble in water. The Tc(VII) valence state is stable in toxic environments and exists as the pertechnetate anion which is weakly sorbed by mineral material and forms few insoluble phases, with consequent high mobility in soil and groundwater. Due to its environmental mobility under oxidizing conditions, management of this type of waste is a challenging task. Tetravalent Tc [Tc(IV)] is the stable valence state under reducing or anoxic conditions and it is sparingly soluble in water. Ferrous iron [Fe(II)] is an important reductant; this has been widely used for removal of pertechnetate through the reduction of Tc (VII) to Tc (IV) as TcO2 and precipitated along with Fe2+/Fe3+ hydroxides. The removal of technetium-99 from low level radioactive liquid waste is being carried out by chemical precipitation method by addition of sodium sulphite and ferrous sulphate in the waste which results in reduction of pertechnetate, from Tc(VII) to Tc(IV) as sparingly soluble TcO2, Tc camouflaged with Fe in FeOOH and co-precipitates along with iron oxy-hydroxide FeOOH. This generates secondary radioactive chemical sludge which requires further management. Aim of this project is to study the feasibility of the reduction and removal of pertechnetate from radioactive liquid waste using zero valent iron and thus minimization of secondary waste. This work covers evaluation of existing method, Technetium removal study using zerovalent iron wool, Synthesis and characterization of zerovalent nano iron and its application in removal of technetium from radioactive liquid waste.

**Keywords:** GM counting system, Single Channel analyser, iron wool, Percentage of removal.

**PP 14**

# DESIGN AND EVALUATION OF mPEG-b-PCL-b-PEC TRIBLOCK COPOLYMER MICELLES FOR CONTROLLED AND TUMOR-SELECTIVE DELIVERY OF CAMPTOTHECIN

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Camptothecin (CPT) is a powerful anticancer agent limited by poor solubility and rapid inactivation of its lactone form. In this work, a triblock copolymer, poly(ethylene glycol)-block-poly(ε-caprolactone)-block-poly(ethylene carbonate) (mPEG-b-PCL-b-PEC), was prepared through sequential ring-opening polymerization to construct a robust nanocarrier for delivering CPT. The copolymer spontaneously formed well-defined micelles with low critical micelle concentration (CMC) and high colloidal stability. CPT-loaded micelles showed excellent encapsulation efficiency and stimuli responsive sustained release, preferring acidic tumor microenvironments while being stable under physiological pH. In vitro experiments validated strong cytotoxicity against MCF-7 breast cancer cells and low toxicity against normal VERO cells. The results clearly indicate that the mPEG-b-PCL-b-PEC micelles can efficiently stabilize CPT, extend its release, and further improve tumor-selective activity, providing a highly promising platform for controlled and biocompatible cancer therapy.

**Keywords:** Camptothecin, Triblock copolymer, Micelles, Drug Delivery, Cancer therapy.

**PP 15**

# A SENSITIVE UHPLC-MS/MS METHOD FOR THE QUANTIFICATION OF FIVE DIFFERENT NITROSAMINE IMPURITIES IN DAPSONE

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A sensitive and reliable UHPLC-MS/MS method to detect and quantify N-nitrosamine impurities in dapsone to ensure patient safety. Nitrosamine impurities were separated using a Phenomenex Kinetex Biphenyl 100 Å (150 mm × 4.6 mm) column. The mobile phase consisted of Solvent A: 0.1% formic acid in water Solvent B: 0.1% formic acid in methanol. The flow rate was 0.6 mL/min. Five nitrosamine impurities were monitored using specific mass transitions: m/z 75.00/43.10, 147.20/117.00, 103.20/75.10, 117.20/75.10, and 131.10/89.20. The method was validated according to ICH guidelines. It showed good signal-to-noise ratios Excellent linearity for all five nitrosamines over low ppm ranges, with correlation coefficients ($r^2$) around 0.99. Low limits of detection (LOD) and quantitation (LOQ), as follows (ppm): N-Nitrosodimethylamine, Nitroso-N-methyl-4-aminobutyric acid: LOD 0.032, LOQ 0.096, N-Nitrosodiethylamine, Nitrosoisopropylethylamine, N-Nitrosodiisopropylamine: LOD 0.006, LOQ 0.018. Recovery and repeatability were within acceptable limits. It Conclude this developed UHPLC-MS/MS method is sensitive, accurate, and reliable for routine detection and quantification of nitrosamine impurities in dapsone samples and can be used for quality control in pharmaceutical analysis.

**Keywords:**N-Nitrosodimethylamine, Nitroso-N-methyl-4-aminobutyric acid, N-Nitrosodiethylamine, Nitrosoisopropylethylamine, N-Nitrosodiisopropylamine, Dapsone, UHPLC-MS/MS, Quantitation.

**PP 16**

# BIOMEMBRANE FROM PALMYRA SPROUT SHEATH EXTRACT INCORPORATED WITH CURCUMIN & PVA - INVITRO AND INVIVO WOUND HEALING ASSAY

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Curcumin was incorporated into the biomembrane which was used for treating wounds as it has higher healing ability. In this study, curcumin extract (CE) was added with polyvinyl alcohol (PVA) which was biodegradable & biocompatible in nature and starting material was palmyra sprout sheath extract because it contains a greater number of active pharmacological compounds. The biomembrane was prepared by solution casting method. The developed Palmyra sprout sheath extract with curcumin and PVA (PCP biomembrane) was analyzed with Fourier Transform-Infrared Spectroscopy (FT-IR), Scanning Electron Microscopy and Energy Dispersive X-rays (SEM-EDX), Thermogravimetric Analysis (TGA), X-Ray Diffraction (XRD), Tensile strength, Thickness, Antibacterial activity, Contact angle measurements, Cytotoxicity and wound scratch assay. The antibacterial activity of the PCP biomembrane was increased by using curcumin. The invitro wound scratch assay shows about 92% of wound closure rate and thus the PCP biomembrane can be used in accelerating the rate of wound healing.

**Keywords:** Biocompatible, Pharmacological compound, PCP biomembrane, Solution casting, Wound scratch, Wound healing.

**PP 17**

# MATERIALS FOR WASTEWATER TREATMENT AND DESALINATION

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Effective wastewater treatment and desalination are crucial to addressing global water scarcity and ensuring sustainable access to clean water. Recent advancements in material science have led to the development of innovative materials with improved efficiency, selectivity, and cost effectiveness for removing contaminants and producing potable water. This poster highlights key classes of materials currently used in wastewater treatment and desalination, including membrane materials, adsorbents, nanomaterials, and catalytic systems. Membrane technologies such as reverse osmosis, nanofiltration, and ultrafiltration provide high rejection of salts, microorganisms, and dissolved pollutants. Adsorbent materials, including activated carbon, zeolites, clays, and biochar, play a major role in capturing dyes, heavy metals, and organic contaminants from industrial and municipal wastewater due to their high surface area and strong affinity for pollutants. Nanomaterials including nano-silver, titanium dioxide, graphene oxide, and carbon nanotubes offer tuneable physicochemical properties that enhance adsorption, photocatalysis, and disinfection processes. Additionally, emerging photocatalytic and electrocatalytic materials provide sustainable methods to degrade persistent chemicals, pharmaceuticals, and pathogens using light or electrical energy. Although these materials show exceptional potential, several challenges remain, including membrane fouling, material degradation, high production costs, and environmental safety concerns associated with nanoparticle release. This poster aims to provide a comprehensive overview of current progress while highlighting the transformative potential of material-based innovations in global wastewater management and desalination systems.

**Keywords:** Wastewater treatment, Desalination, Membrane technologies, Adsorbent materials, Nanomaterials

**PP 18**

# DEVELOPMENT OF ECO-ENZYME FROM KITCHEN WASTE

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Eco-enzymes—also known as garbage enzymes—are organic solutions produced through the fermentation of common kitchen waste such as fruit peels, vegetable scraps, and leftover plant materials. Their development has gained significant attention as a sustainable, low-cost method for converting domestic organic waste into useful biochemical products. Typically, eco-enzymes are prepared by fermenting kitchen waste with jaggery or brown sugar and water for a period of three months. During fermentation, naturally occurring microorganisms break down complex organic matter and generate enzymes, organic acids, and beneficial microbial metabolites. These products possess strong cleansing, antimicrobial, and deodorizing properties, making eco-enzymes valuable for household cleaning, agriculture, wastewater treatment, and even pest control.

The development of eco-enzymes contributes significantly to waste management by reducing the volume of biodegradable waste that would otherwise end up in landfills, where it generates methane and causes environmental pollution. Moreover, eco-enzymes are non-toxic and biodegradable, providing an eco-friendly alternative to commercial chemical cleaners that often contain harmful compounds. Their application in agriculture—such as soil improvement, plant growth promotion, and natural pesticide activity—further enhances environmental sustainability.

This process empowers households and communities to actively participate in circular waste management practices, transforming everyday kitchen waste into valuable resources. With rising environmental awareness and increasing concern about waste generation, eco-enzymes represent a practical and accessible solution that supports green living and contributes to long-term ecological conservation.

**Keywords:**Eco-enzymes, kitchen waste, fermentation, waste management, organic cleaners, sustainability.

**PP 19**

# OPTIMIZATION OF NUTRIENT SOURCES FROM VEGETABLE WASTES FROM VERMICOMPOST

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The growing demand for sustainable soil amendments has increased interest in converting organic waste into nutrient-rich vermicompost. Vegetable wastes, generated abundantly from households, markets, and food processing units, serve as excellent biodegradable substrates for earthworm-mediated composting. This study focuses on optimizing nutrient sources from mixed vegetable wastes to enhance the quality and efficiency of vermicompost production. Different combinations of vegetable residues such as leafy greens, fruit peels, tuber residues, and legume wastes were analyzed for moisture content, carbon-to-nitrogen ratio, and biodegradability. Pre-processing steps, including shredding and partial pre-composting, were standardized to improve palatability for Eisenia fetida, the selected earthworm species. Experimental setups were maintained under controlled temperature and moisture conditions to assess nutrient transformation. Vermicompost samples were evaluated for key parameters such as pH, electrical conductivity, organic carbon, available nitrogen, phosphorus, potassium, micronutrients, and earthworm biomass gain. The results indicated that optimized mixtures of vegetable waste with balanced C:N ratios (25:1–30:1) significantly improved decomposition rates and nutrient enrichment. The final vermicompost produced from optimized substrates showed enhanced levels of NPK, improved humus content, and better texture compared to non-optimized waste mixtures. This study demonstrates that vegetable wastes are highly suitable for vermicompost production when appropriately formulated, contributing to effective waste management and soil fertility enhancement.

**Keywords:**Vermicompost, Vegetable Waste, Nutrient Optimization, Organic Fertilizer, Earthworms, Sustainable Waste Management

**PP 20**

# PRODUCTION OF ALPHA-AMLYASE FROM AGRICULTURAL WASTES

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Agricultural wastes represent an abundant, low-cost, and nutrient-rich resource that can be effectively utilized for sustainable enzyme production. This study focuses on the production of α-amylase using selected agricultural residues, including rice bran, wheat bran, potato peels, and fruit wastes, as alternative substrates for microbial fermentation. α-Amylase is an important industrial enzyme widely used in food processing, textiles, pharmaceuticals, and biofuel industries due to its ability to hydrolyze starch into simpler sugars. Conventional enzyme production relies on expensive synthetic media, which increases overall manufacturing costs. To address this challenge, agricultural wastes were pretreated, dried, and incorporated as carbon sources for microbial growth. Suitable α-amylase–producing microorganisms were cultivated under optimized physical and nutritional conditions such as pH, temperature, moisture content, and incubation time. Fermentation was carried out using either solid-state fermentation (SSF) or submerged fermentation (SmF), depending on the substrate characteristics. Enzyme extraction, crude purification, and activity assays were performed using standard starch-iodine and DNS methods. The results indicated that agro-wastes not only supported high microbial growth but also significantly enhanced α-amylase production compared to conventional media. This cost-effective strategy also promotes environmental sustainability by converting biodegradable waste into valuable bioproducts. Overall, the study demonstrates that agricultural residues are promising substrates for large-scale α-amylase production, contributing to waste valorisation, reduced production costs, and the development of eco-friendly bioprocessing technologies.

**Keywords:** α-Amylase; Solid-state fermentation; Submerged fermentation; Microbial enzyme production; Waste valorisations; Sustainable biotechnology.

# PRODUCTION OF OYSTER MUSHROOM (PLEUROTUS SPP)

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The production of oyster mushroom (Pleurotus spp.) represents one of the most sustainable, low cost, and high nutritional value biotechnological processes, making it an ideal model for eco friendly food production. This study focuses on optimizing the cultivation of oyster mushrooms using locally available agricultural waste substrates, thereby reducing environmental impact while enhancing yield. Substrates such as paddy straw, sugarcane bagasse, and wheat straw were pre-treated, pasteurized, and inoculated with high quality spawn. Growth parameters including spawn run period, pinhead initiation, biological efficiency, and overall yield were monitored throughout the production cycle. Among the substrate combinations tested, paddy straw showed the fastest colonization, while a mixture of paddy straw and sugarcane bagasse produced the highest biological efficiency. Environmental factors such as humidity (80–90%), temperature (25–28°C), and diffused light significantly influenced fruiting body development, ensuring efficient mushroom production. The study highlights the potential of oyster mushroom cultivation as an income generating enterprise for rural communities, given its low investment requirements and fast production cycle. Additionally, the use of agricultural waste as substrate promotes waste valorisation and contributes to a sustainable cultivation model. Overall, this work demonstrates that optimized substrate selection and environmental control can substantially improve oyster mushroom yield, sustainability, and commercial feasibility. This approach enhances yield, nutritional quality, and medicinal value, while controlled cultivation maintains consistent morphology and shelf life. Using easily available waste materials lowers costs, making mushroom farming economically attractive, scalable with minimal training, and a sustainable livelihood option.

**Keywords:** Oyster mushroom, Pleurotus spp., Agricultural waste substrate,biological efficiency, Sustainable cultivation, Yield optimization.

**PP 22**

# PRODUCTION OF BIOPLASTIC FROM ALGAE

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The increasing environmental impact of conventional petroleum-based plastics has accelerated the search for sustainable and biodegradable alternatives. Algae-based bioplastics have emerged as a promising solution due to their renewable nature, rapid growth rate, and minimal requirement for arable land or fresh water. This study focuses on the production of bioplastic from algae, emphasizing its potential to reduce plastic pollution and dependence on fossil resources. Algae are rich in natural polymers such as polysaccharides, starch, and proteins, which can be effectively utilized as raw materials for bioplastic synthesis. The production process generally involves algal cultivation, harvesting, drying, and extraction of biopolymers, followed by blending with plasticizers like glycerol to enhance flexibility and moldability. Compared to conventional crops, algae offer higher biomass productivity and can be cultivated using wastewater or saline water, making the process more environmentally sustainable. The resulting algal bioplastics exhibit favorable properties such as biodegradability, non-toxicity, and reduced carbon footprint. Although challenges such as mechanical strength, water sensitivity, and large-scale production costs still exist, ongoing advancements in material processing and biotechnology are steadily improving performance and feasibility. The use of algae for bioplastic production not only addresses waste management issues but also contributes to carbon dioxide sequestration during algal growth. Overall, algae-based bioplastics represent a viable and eco-friendly alternative to traditional plastics and hold significant promise for applications in packaging, agriculture, and biomedical fields, supporting a more sustainable and circular bioeconomy.

**Keywords:** Bioplastics, Algae-based materials, Biodegradability, Sustainable plastics, Renewable resources, Eco-friendly polymers, Circular bioeconomy.

**PP 23**

# FROM BENCH TO BREAKTHROUGH: CUTTING-EDGE PROGRESS IN DENGUE VACCINE INNOVATION

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Dengue fever remains a critical global health challenge, driven by rising case numbers, increasing geographic spread of Aedes mosquitoes, and the complex immune interactions associated with its four distinct serotypes. Recent advances in molecular virology, immunogen design, and translational vaccine science have significantly accelerated the path from laboratory discovery to clinical application. This presentation highlights the latest breakthroughs shaping next-generation dengue vaccine development, integrating insights from structural vaccinology, systems immunology, and platform-based innovation. Novel vector-based and nucleic acid vaccine platforms, including mRNA and self-amplifying RNA constructs, have demonstrated promising immunogenicity profiles in preclinical models, offering rapid adaptability and scalable manufacturing advantages. Advances in epitope mapping and neutralizing antibody characterization have further guided precision antigen design, enabling vaccines to target conserved viral structures with high specificity. Additionally, the integration of adjuvant optimization, real-time Sero-epidemiological modelling, and improved clinical trial frameworks is reshaping how efficacy, safety, and population-level impact are assessed. Emerging multivalent and pan-flavivirus vaccine candidates hold particular promise for regions burdened by co-circulating arboviruses. Collectively, these innovations mark a transformative shift in dengue vaccine science bridging foundational bench research with translational milestones and offering renewed optimism for global dengue prevention. This presentation synthesizes state-of-the-art advancements and outlines strategic pathways to accelerate deployment, equity, and long-term impact of next-generation dengue vaccines worldwide.

**Keywords:** Dengue vaccine, immunogenicity, tetravalent design, antibody-dependent enhancement, structural vaccinology

# PRODUCTION OF BIOPLASTIC FROM ALGAE

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Bioplastic made from algae is becoming an important eco-friendly alternative to normalplastics, which cause pollution and take many years to break down. This study focuses on howbioplastic can be produced using algae, a fast-growing and renewable natural resource. Algaeare chosen because they grow quickly, need very little land, and can even grow in wastewateror seawater. This makes them a low-cost and environment-friendly option for bioplasticproduction.In this work, algae were collected, dried, and crushed to obtain useful substancessuch as natural polymers (like agar, alginate, and carrageenan). These polymers act like natural"building blocks" for making bioplastic. To improve flexibility and strength, the extractedmaterial was mixed with glycerol, a common plasticizer. The prepared mixture was then pouredinto Molds or thin trays and allowed to dry into film-like sheets, forming the final bioplasticproduct.The bioplastic produced from algae showed good strength, flexibility, and the abilityto biodegrade naturally. Compared to normal plastics, algae bioplastic produces less pollutionand breaks down faster in soil. It is also safe, renewable, and requires less energy to produce.These qualities make it suitable for packaging materials, disposable items, and otherenvironmentally friendly products.Overall, this study shows that algae can be successfully usedto produce bioplastic in a simple and sustainable way. With further research to reduce costs andimprove quality, algae-based bioplastics could become a practical solution to reduce the globalplastic pollution problem.

**Keywords:** Algae, Bioplastic, Eco-friendly, Biodegradable, Polymers, Glycerol

**PP 25**

# CARBON QUANTUM DOTS

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Carbon Quantum Dots (CQDs) have emerged as a promising class of carbon based nanomaterials due to their excellent photoluminescence, biocompatibility, chemical stability, and low toxicity. In recent years, sustainable synthesis routes using food waste precursors have gained significant attention as an eco-friendly and cost-effective approach to large scale CQD production. This study reports the green synthesis of CQDs derived from selected food wastes such as fruit peels, vegetable residues, and carbohydrate rich kitchen discards through a simple hydrothermal carbonization method. The resulting CQDs displayed strong fluorescence, uniform particle size distribution (2–8 nm), and high aqueous dispersibility, making them suitable for biological applications.

Comprehensive characterization was performed using UV–Vis spectroscopy, photoluminescence (PL) spectroscopy, TEM, FTIR, and XRD, confirming the presence of surface functional groups such as –OH, –COOH, and $–NH_2$ , which enhanced both water solubility and target molecule binding. The synthesized CQDs exhibited excitation-dependent fluorescence, enabling multicolour imaging in cellular systems. Cytotoxicity assays revealed excellent biocompatibility at relevant concentrations, demonstrating their suitability for bioimaging applications in live cells. Furthermore, functionalization of CQDs with selective molecular probes enabled their use in biosensing platforms for detecting metal ions (e.g., $Fe^{3+}$ , $Hg^{2+}$ ) and biomolecules (e.g., glucose, dopamine) with high sensitivity and rapid response times.

Overall, this work highlights the dual advantages of waste valorisation and advanced nanomaterial production. The sustainable synthesis of fluorescent CQDs from food waste offers a low cost, scalable, and environmentally friendly pathway for developing next generation tools in biomedical imaging, diagnostics, and sensing technologies.

**PP26**

# FABRICATION AND ELECTROCHEMICAL EVALUATION OF CARBON-INTERCALATED Ce-DOPED $SrTi_2O_3$ NANOHYBRIDS FOR HIGH-PERFORMANCE SUPERCAPACITOR APPLICATION

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A novel nanohybrid electrode material containing carbon-intercalated cerium doped strontium titanate (AC@Ce/$SrTi_2O_3$) has been prepared by a controlled hydrothermal synthesis followed by subsequent carbon intercalation. The activated nanocarbon were prepared from (Pistachio nutshell) via chemical activation method. The X-ray diffraction spectrum (XRD) confirms that high crystallinity and successful phase integration of Ce/$SrTi_2O_3$ within the carbon framework. FE-SEM and TEM imaging revealed a uniform intercalated morphology. UV-Vis spectroscopy demonstrated a band gap narrowing from 3.2 eV ($SrTi_2O_3$) to 2.2 eV upon Ce-doping and activated nanocarbon incorporation, suggesting enhanced electron transport properties. The electrochemical characterizations including cyclic voltammetry, galvanostatic charge-discharge, and electrochemical impedance spectroscopy revealed significantly enhanced specific capacitance, extraordinary rate performance across diversified current densities, and outstanding cyclic stability over extended charge-discharge cycles. The excellent electrochemical performance could be related to the pseudocapacitive contribution from Ce redox activity. This work demonstrates the great potential of carbon-intercalated Ce-doped $SrTi_2O_3$ oxide nanocomposites as an advanced electrode material in developing high-performance and durable supercapacitors toward advanced electrochemical energy storage for flexible and wearable electronics applications.

**Keywords:** Nano Hybrid Electrode, Hydrothermal Synthesis, Activated Nanocarbon, Pseudocapacitive behaviour, Sustainable Energy Materials.

**PP 27**

# TAILORED SOL-GEL DERIVED $ZrO_2/WO_3$ NANOHYBRIDS AS RESILIENT ELECTRODES TOWARD NEXT-GENERATION SUPERCAPACITORS

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This study demonstrates the successful synthesis of zirconium dioxide/tungsten trioxide ($ZrO_2/WO_3$) in a 1:1 stoichiometric ratio using a simple and cost-effective sol-gel approach. The physiochemical characteristics of the nanoparticles is examined through FTIR, XRD and UV-vis spectroscopy. The XRD pattern reveals that the synthesized nanoparticle has high crystalline nature. UV-Vis spectroscopy showed a band gap decrease from 5.1 eV (pure $ZrO_2$) to 2.5 eV after $WO_3$ doping indicating improved electron transport characteristics. The electrochemical characterization for 3 electrode system in 1 M $Na_2$ $SO_4$ electrolyte using cyclic voltammetry (CV), galvanostatic charge-discharge (GCD) and Electrochemical Impedance Spectroscopy (EIS) techniques revealed a maximum specific capacitance of 1291 F/g at 1 A/g for $ZrO_2/WO_3$ electrodes. After 5000 cycles, the composite maintained 95.2% capacitance retention, indicating high cycling stability. The synergistic effects of $ZrO_2$ doping and $WO_3$ integration significantly improved charge storage kinetics and stability, making this nanocomposite a promising candidate for advanced super capacitive electrode applications.

**Keywords:** Nanoparticle, sol-gel method, ZrO2/WO3, electrochemical study, nanohybrid, supercapacitor

**PP 28**

# GREEN SYNTHESIS OF ZINC OXIDE/CARBON NANOCOMPOSITES FOR SUPERCAPACITORS APPLICATION

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This study focuses on producing activated carbon (AC) from the biomass of *Sapindus Trifoliatus* seeds through chemical activation with KOH in an initial phase, yielding nanoporous layered carbon sheets with a large surface area. Additional steps involve nitrogen and sulfur doping to create N/S-AC, followed by zinc oxide co-doping to form the N/S-doped AC sample (N/S-AC-ZnO). X-ray diffraction (XRD) analysis confirms the high crystallinity and successful integration of N/S-ZnO within the carbon framework. High-resolution scanning electron microscopy (HR-SEM) reveals that the AC exhibits a morphology characterized by nano porous layered sheets, while N/S-AC@ZnO displays flower-like zinc oxide structures well incorporated on these sheets. UV-Vis spectroscopy indicates a band gap of 3.15 eV for N/S-AC@ZnO. The electrochemical performance of the supercapacitor has been assessed using cyclic voltammetry (CV), charge-discharge curves (GCD), and electrochemical impedance spectroscopy (EIS), revealing a maximum specific capacitance of 531.53 F/g at 1 A/g for the AC electrodes, which significantly increased to 2000.01 F/g at 1 A/g for N/S-AC@ZnO nanocomposite in a 0.1 M $Na_2 SO_4$ solution. After 5000 cycles, the composite demonstrated a capacitance retention of 95.2%, indicating strong cycling stability. The improved charge storage kinetics and stability suggest that this nanocomposite is a promising candidate for advanced supercapacitor applications.

**Keywords:**Nanocomposite, *Sapindus trifoliatus* seeds, biomass derived activated carbon, electrochemical study, supercapacitors application

**PP 29**

# BIO-CARBON REINFORCED Gd-DOPED $NiWO_4$ AS A BIFUNCTIONAL ELECTROCATALYST FOR ENERGY STORAGE APPLICATIONS

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A hydrothermal synthesis strategy was employed to develop multifunctional nanocomposites comprising pristine $NiWO_4$ , Gd-doped $NiWO_4$ (Gd/$NiWO_4$ ), and activated carbon–supported Gd/$NiWO_4$ (AC/Gd/$NiWO_4$ ). Pistachio shell–derived activated carbon (AC) acted as a sustainable micro–mesoporous conductive scaffold, offering high surface area and interconnected pore channels that facilitated rapid ion transport and improved electron mobility. X-ray diffraction confirmed the successful incorporation of $Gd^{3+}$ into the $NiWO_4$ lattice, generating structural distortion and oxygen vacancies that enhanced the electronic bandwidth. Morphological analyses via FESEM and TEM revealed uniform nanoparticle dispersion and strong interfacial contact between Gd/$NiWO_4$ and the carbon matrix. HRSEM images of Gd/$NiWO_4$ displayed nanosheet-like structures, while pristine $NiWO_4$ showed distinct nanocubes-like morphologies; in the AC/Gd/$NiWO_4$ composite, these nanocubes were uniformly anchored across the porous carbon network, significantly improving surface accessibility and mitigating particle agglomeration. UV–Vis spectroscopy confirmed band-structure modulation upon Gd doping and AC integration, further supporting enhanced electron-transfer characteristics. Electrochemical analysis demonstrated that although pure $NiWO_4$ exhibited modest capacitive behavior due to limited conductivity, Gd doping substantially increased the density of redox-active sites and improved charge-transfer kinetics. The combined effects of Gd-induced electronic restructuring and AC-mediated conductivity enhancement enabled AC/Gd/$NiWO_4$ to deliver markedly higher specific capacitance, faster charge–discharge response, and excellent long-term cycling stability. In addition, the nanocomposite displayed enhanced bifunctional electrocatalytic activity toward both the hydrogen evolution reaction (HER) and oxygen evolution reaction (OER), attributed to synergistic interactions among Ni,

W, Gd, and the conductive carbon framework. These integrated structural and electronic advantages position AC/Gd/$NiWO_4$ as a promising and sustainable candidate for next-generation hybrid energy devices combining high-performance supercapacitive storage with efficient water-splitting electrocatalysis.

**Keywords:** Gadolinium doping; Activated carbon; Pistachio shell biomass; Supercapacitor; Electrocatalysis; HER; OER; Hydrothermal synthesis; Nanocomposite.

**PP 30**

# ENHANCED PHOTOCATALYTIC DEGRADATION OF MALACHITE GREEN AND ACID BLUE 113 DYES USING $WO_3$ /GRAPHENE NANOCOMPOSITES

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In this present work, a hydrothermal method was employed to synthesize binary $WO_3$ /graphene nanocomposites. The structural and optical properties of the synthesized nanocomposite were systematically analyzed using a range of characterization techniques, including ultraviolet–visible (UV–Vis), Raman, photoluminescence (PL) spectroscopy SEM, HRTEM, EDX, XRD and XPS. SEM-EDX analysis confirmed the successful incorporation of graphene into $WO_3$ , with EDX further validating the presence of the expected chemical elements. The photocatalytic performance of the $WO_3$ /graphene nanocomposite was evaluated by testing its ability to degrade acid blue 113 and malachite green dyes under direct sunlight irradiation. The optimization of key operational parameters, including catalyst dosage, pH, pollutant concentration, and electrolyte effects, was thoroughly studied to enhance photocatalytic efficiency. The results revealed that the nanocomposite achieved 93% degradation of AB 113 within 120 minutes and 92% degradation of MG within 180 minutes, demonstrating its superior photocatalytic activity. These findings suggest that the $WO_3$ /graphene nanocomposite holds significant potential for the effective removal of organic pollutants from industrial wastewater, positioning it as a promising material for sustainable environmental remediation applications.

**Keywords:** Synthesis, characterization, $WO_3$ /graphene nanocomposites, Photocatalytic degradation.

# INVESTIGATION OF PHOTOCATALYTIC DEGRADATION OF BIODEGRADABLE POLYETHYLENE BY NITROGEN DOPED $TiO_2$ / NITROGEN DOPED REDUCED GRAPHENE OXIDE NANOCOMPOSITE FOR SUSTAINABLE SMART MATERIALS

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The unabated discharge of harmful contaminants due to accelerated consumption of plastics result in environmental pollution. Besides, investigation on Photocatalytic degradation of plastics employing $TiO_2$ and modified TiO2 has recorded exemplary results. Hence, we propose that incorporation of TiO2 fabricated with nitrogen and nitrogen doped RGO nanocomposite (NTNG) onto polyethylene (PE) results in biodegradable polyethylene (BPE). This novel material augments the photocatalytic degradation of polyethylene by reducing the recombination rate and enhancing the transfer of electrons respectively. Availability of electrons and holes favours the generation of reactive oxygen species (O2- , O-) and hydroxyl radicals (OH). These reactive species initiate the degradation reaction by attacking carbons in polyethylene to produce carbon-centred radicals. Once the carbon-centred radicals are introduced in the polymer chain, their successive reactions with the oxygen incorporation will lead to the chain cleavage. Further degradation of intermediate species results in CO2 and H2O which undergoes microbial degradation for a benign environment circulation. Photocatalyst incorporated BPE has been analysed employing XRD, UV Vis, FESEM, EDS, CHN and XPS. Investigation of the photodegradation of BPE was observed by exposing the nanocomposite under UV-Visible radiation using UV chamber.

**Keywords:** Photocatalytic degradation, TiO2, Biodegradable, Polyethylene and Reduced graphene Oxide.

**PP 32**

# BIOSORPTIVE REMOVAL OF COPPER FROM AQUEOUS SOLUTION USING A CHITOSAN BLEND WITH GARCINIA-DERIVED BIOCHAR

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The present study investigates the efficacy of a chitosan–Garcinia plant biochar blend in the biosorptive elimination of copper from water. Biochar was produced from Garcinia plant biomass via pyrolysis at 550 °C under a nitrogen atmosphere and then mixed with a chitosan solution. The synthesized chitosan–Garcinia biochar (CS–GBC) composite was characterized using FTIR, XRD, BET, and SEM analyses. Batch adsorption experiments were performed to determine the Cu(II) removal efficiency of the CS–GBC blend under varying conditions, including pH, initial metal concentration, contact time, and adsorbent dosage. The optimum pH for Cu(II) adsorption was found to be 6, at which the CS–GBC composite achieved a maximum sorption capacity of 287.45 mg/g. Adsorption efficiency increased steadily with adsorbent dosage up to 3 g and contact time up to 360 minutes. Isotherm analysis revealed that the adsorption process fit best with the Langmuir model, indicating monolayer sorption. Kinetic studies confirmed that the adsorption followed a pseudo-first-order model. Desorption using 0.05 M HCl showed strong regeneration potential, enabling 93% recovery of Cu(II) ions. Overall, the study demonstrates that the chitosan–Garcinia plant biochar blend is a highly effective, sustainable, and economically feasible adsorbent for removing copper from aqueous solutions.

**Keywords:** Chitosan–Garcinia biochar composite; Copper adsorption; Biosorption; Heavy metal removal; Langmuir isotherm; Pseudo-first-order kinetics; Regeneration; Aqueous solution treatment; Sustainable adsorbent; Pyrolysis.

**PP 33**

# INTERFACIAL POLYMERIZATION TO SYNTHESIS AuNPs@PPY/rGO NANOCOMPOSITES FOR THE SIMULTANEOUS VOLTAMMETRIC QUANTIFICATION OF HYDRAZINE AND NITRITE IN WATER

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Gold nanoparticles modified polypyrrole/reduced graphene oxide nanocomposites (AuNPs@PPy/rGO) were synthesized by an interfacial polymerization method. The prepared nanocomposites were isolated and characterized using various analytical techniques to find the morphology, crystalline nature, and functional groups. Methods: The AuNPs@PPy/rGO modified GCE was further evaluated by EIS and CV techniques. Moreover, the nanocomposites improved electrocatalytic activity is in acquiring lower overpotentials, high peak current densities, and a large surface area. Chronoamperometric studies were used to measure the diffusion coefficient ($1.23 \times 10^{-5}$ $cm^2/s$ and $2.17 \times 10^{-5}$ $cm^2/s$) and catalytic reaction rate constant ($4.05 \times 10^6$ $M^{-1}s^{-1}$ and $9.60 \times 10^5$ $M^{-1}s^{-1}$) of hydrazine and nitrite. The DPV technique was employed to determine the individual as well as simultaneous determination of both analytes, and the detection limit was found to be 1.6 and 1.2 nM for hydrazine and nitrite at AuNPs@PPy/rGO/GCE. Significant contribution: Fabricated electrodes reveal better outstanding features like long-term stability, repeatability, and strong anti-interference ability. Finally, the proposed electrode was used to determine the hydrazine and nitrite concentration in water samples (drinking, tap, and lake) with better recovery ranges.

# SYNTHESIS, BIOLOGICAL EVALUATION AND DOCKING STUDIES OF NEW PENDANT-ARMED BINUCLEAR NICKEL(II) COMPLEXES

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A series of binuclear nickel(II) complexes $[Ni_2L^{1–3}](ClO_4)_2$ (1–3)with three different benzoyl pendant-arms have been synthesized by cyclocondensation between 2,6-diformyl-4-bromophenol with 2,2'-benzoyliminodi(ethylamine) trihydrochloride, 2,2'-4-nitrobenzoyliminodi(ethylamine) trihydrochloride and 2,2'-3,5-dinitrobenzoyliminodi(ethylamine) trihydrochloride in the presence of nickel(II) perchlorate and characterized by spectral methods. The IR spectra of complexes suggest the presence of uncoordinated perchlorate anions. Cyclic voltametric studies evidenced two quasi-reversible one electron reduction and oxidation waves in the cathodic and anodic region, respectively. All the compounds were tested for antibacterial activity against Gram (–ve) and Gram (+ve) bacterial strains. The binding studies of complexes with CT–DNA suggest intercalative mode of interaction. The cytotoxic activity of complexes on human liver adenocarcinoma (HepG2) cell line has been examined. Nuclear-chromatin cleavage has also been observed with PI staining assay. Furthermore, the molecular docking study was also carried out to ascertain the mode of action towards the molecular target DNA and with the enzyme EGFR tyrosine kinase.

**PP 35**

# STRONTIUM-DOPED MESOPOROUS BIOACTIVE GLASS NANOPARTICLES: SYNTHESIS, CHARACTERIZATION, AND BIOMEDICAL POTENTIAL

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This study primarily focuses on characterizing Sr-MBGNPs for bone tissue engineering applications. Oxalic acid was used to enhance hydrolysis in the sol-gel process, improving nanoparticle formation. These characterizations are essential to evaluate bioactivity, safety, and functionality relevant to bone regeneration.Utilizing the sol-gel method with oxalic acid as a catalytic agent for hydrolysis, we prepared Sr-MBGNPs and subsequently assessed their biological activities, cytotoxicity, antibacterial properties, and drug release profiles. The structural integrity, morphology, size, and shape of the nanoparticles were confirmed through various instrumental analyses, including X-ray diffraction (XRD), which validated the formation of Sr-MBGNPs. In simulated body fluid, the nanoparticles facilitated the formation of apatite crystals, indicative of their bioactivity. Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-OES) was employed to analyse the release of key metal ions (Sr, Ca, P, and Si), further supporting the material's therapeutic potential. Additionally, Sr-MBGNPs demonstrated significant antibacterial activity against Staphylococcus aureus and *Escherichia coli*. These findings suggest that the incorporation of strontium into the bio glass network enhances its multifunctional properties, positioning Sr-MBGNPs as promising candidates for bone tissue engineering applications.

**Keywords:** Strontium, bioactive nanoparticles, nanoparticles, antibacterial, bone tissue engineering

**PP 36**

# MYCO-ENGINEERED MAGNESIUM OXIDE (MGO) NANOPARTICLES FROM AYAPANA TRIPLINERVIS ENDOPHYTE: A DUAL-FUNCTIONAL APPROACH FOR BIOMEDICAL AND ENVIRONMENTAL APPLICATIONS

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The increasing global burden of pollution-linked illnesses, rising resistance to conventional therapies, and environmental toxicity of synthetic agents underscore the urgent need for sustainable biomedical and environmental solutions. This study aims to develop eco-friendly magnesium oxide nanoparticles (MgO-NPs) using a novel fungal endophyte, Daldinia sp., isolated from the medicinal plant Ayapana triplinervis, and to evaluate their multifunctional bioactivity. The isolated fungal strain, A1 was identified as Daldinia sp. through molecular characterization studies. An eco-friendly myco-synthesis method was employed using the fungal filtrate of strain A1 to produce magnesium oxide nanoparticles (AT-MgONs), which were characterized to be uniform, crystalline and well-dispersed spherical structures through various spectroscopic characterization techniques. The AT-MgONs exhibited strong anticancer potential against A549 lung cancer cells by effectively disrupting cell proliferation, triggering programmed cell death and inhibiting the migration of cells. Additionally, AT-MgONs induced significant mortality in Aedes aegypti larvae, exhibiting LC50 and LC90 values of 52.722 and 136.163 µg/mL respectively, against IV instar larvae and 99.548 and 214.545 µg/mL respectively, against pupae. Further, the AT-MgONs exhibited significant photocatalytic degradation of azo dyes—achieving 55% and 88% degradation of methyl orange and methyl red respectively, within 60 min under sunlight, following pseudo-first-order kinetics. These findings highlight the potential of endophytic fungi as sustainable platforms for green nanoparticle synthesis with dual applications in cancer therapeutics and environmental remediation.

**PP 37**

# PHYTO-ASSISTED SYNTHESIS AND BIOACTIVITY OF SILVER NANOPARTICLES DERIVED FROM *GARCINIASPICATA* FRUIT EXTRACT

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This study investigates the phyto-assisted synthesis of silver nanoparticles (AgNPs) using fruit extract of Garcinia spicata (GS), leveraging its rich phytochemical composition and eco-friendly nature. The formation of GS-AgNPs was initially confirmed by UV–Vis spectroscopy through the appearance of a characteristic surface plasmon resonance peak at 420 nm. Further characterization using X-ray diffraction (XRD), Fourier-transform infrared (FTIR) spectroscopy, and field-emission scanning electron microscopy (FESEM) verified the crystalline structure, morphology, and biomolecular capping of the nanoparticles. FESEM analysis revealed predominantly spherical nanoparticles ranging from 30 to 60 nm in size. The green-synthesized GS-AgNPs exhibited strong antibacterial activity against Streptococcus pyogenes and Escherichia coli at a concentration of 12 µg/mL. Anti-inflammatory potential was also demonstrated through protein denaturation, membrane stabilization, and nitric oxide scavenging assays, all of which showed notable inhibition of inflammatory mediators. Overall, the findings highlight Garcinia spicata as a promising and sustainable source for the phyto-assisted synthesis of AgNPs with potential applications in antibacterial and anti-inflammatory therapies. To the best of our knowledge, this is the first report documenting the biogenic synthesis of AgNPs using Garcinia spicata fruit extract.

**Keywords:** Phyto-assisted synthesis; Silver Nanoparticles (AgNPs); Garcinia spicata; Antibacterial Activity; Anti-Inflammatory Properties; Biomedicine

**PP 38**

# SYNTHESIS OF ZINC OXIDE/HYDROXYAPATITE COMPOSITES COMBINED WITH PVA FOR BONE TISSUE ENGINEERING APPLICATIONS

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In this study we have reported the synthesis ZnO/HAP/PVP composites by simple casting method with different weight percentage (0, 10, 20, 30, 40 and 50 wt %) of PVA. The prepared composites were characterized using powder XRD, FT-IR, TEM and SEM to examine the phase formations, functional groups and surface morphology of prepared composites. In addition, we have also studied the *In-vitro* bioactivity, antimicrobial, porosity, swelling, mechanical, antimicrobial activity and *in-vitro*hemo compatibility of the (ZnO/HAP)/PVP) composite and we found that the prepared materials showed the better activity when compared to pure ZnO/HAP composite. This results clearly indicates that the composite can be used for bone tissue engineering applications (BTE).

**Key words:**Zinc Oxide, Hydroxyapatite, PVA, *in-vitro*hemo compatibility, Bioactivity.

**PP 39**

# GREEN SYNTHESIS OF Mn DOPED $V_2$ $O_5$ /CARBON NANOSHEET COMPOSITES VIA TEMPLATE-FREE BIOMASS ACTIVATION FOR HIGH-PERFORMANCE SUPERCAPACITOR APPLICATIONS

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A simple sol-gel approach was used to create a new nanoporous carbon sheets (NPC) intercalated with Mn doped $V_2$ $O_5$ nanocomposite (1:0.8:1 molar ratio). The nanoporous carbon sheets were made from pistachio nutshell biomass using KOH chemical activation, resulting in a large surface area. X-ray diffraction (XRD) revealed good crystallinity and successful phase integration of Mn/$V_2$ $O_5$ in the carbon framework. FE-SEM and TEM imaging showed homogeneous intercalation of NPC and Mn/$V_2$ $O_5$ nanoparticles. UV-Vis spectroscopy showed a band gap decrease from 2.4 eV (pure $V_2$ $O_5$ ) to 1.28 eV after Mn doping and NPC addition, indicating improved electron transport characteristics. Electrochemical characterization in 1 M $Na_2$ $SO_4$ electrolyte using cyclic voltammetry (CV) and galvanostatic charge-discharge (GCD) techniques revealed a maximum specific capacitance of 461.7 F/g at 1 A/g for Mn/$V_2$ $O_5$ electrodes, significantly increased to 1730.6 F/g for the NPC intercalated composite. After 5000 cycles, the composite maintained 92.6% capacitance retention, indicating high cycling stability. The synergistic effects of Mn doping and NPC integration significantly improved charge storage kinetics and stability, making this nanocomposite a promising candidate for advanced super capacitive electrode applications.

**Key words:** Nanocomposite, pistachio nutshell Intercalation, electrochemical study, supercapacitor application.

**PP 40**

# SUSTAINABLE Ni-$ZrO_2$/ACTIVATED CARBON HYBRID FOR ENHANCED ENERGY STORAGE

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Nanocomposites have emerged as a new class of advanced materials that combine the unique properties of two or more components at the nanoscale, resulting in enhanced structural, electrical, and electrochemical performance. Their tunable composition, large surface area, and synergistic interactions make them highly suitable for energy storage applications such as supercapacitors. In this study, the incorporation of nickel into the $ZrO_2$ lattice and its subsequent dispersion on the activated carbon support significantly enhanced the electrical conductivity, surface area, and charge storage capability of the composite material. The presence of pistachio nutshell-derived activated carbon not only provided a large surface area for ion adsorption but also improved the electrode–electrolyte interface, facilitating rapid charge transfer and reducing internal resistance. As a result, the Ni-$ZrO_2$ /PNSAC nanocomposite exhibited superior electrochemical performance, including higher specific capacitance, better cyclic stability, and enhanced energy density compared to pure $ZrO_2$ and Ni-$ZrO_2$ samples. This synergistic effect between the doped metal oxide and the biomass-derived carbon support highlights the potential of nanocomposites as efficient, sustainable electrode materials for next-generation supercapacitor applications.

**Keywords:** Ni-doped $ZrO_2$ , Activated carbon, Pistachio nutshell, Supercapacitor.

**PP 41**

# PEROXIDASE MIMICS ACTIVITY OF NIO-DOPED GRAPHITIC CARBON NITRIDE NANO SHEETS UTILIZED FOR THE COLORIMETRIC DETECTION OF MERCURY IONS IN AQUEOUS SOLUTIONS

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A switch 'on-off' colorimetric sensor was synthesized to detect the presence of mercury ions. We have successfully synthesized nickel oxide doped graphitic carbon nitride (NiO-g-$C_3N_4$)nanosheets by hydrothermal method. SEM, TEM, XRD, and FT-IR characterized the synthesized (NiO-g-C3N4) nanosheets. The intrinsic peroxidase mimic activity of (NiO-g-$C_3N_4$) nanosheets enhances the catalytic oxidation of the substrate TMB in the presence of $H_2O_2$ to produce a deep blue colour change. The addition of cysteine decolorized the solution. $Hg^{2+}$ had a strong affinity to thiolated compounds. In addition to cysteine and Hg2+ in the system, the solution would be recovered as a blue-coloured solution in the presence of the synthesized nanosheets. In this way, we have developed a facile and rapid colorimetric detection of $Hg^{2+}$ ions in aqueous solutions, and proposed sensor was applied to detect $Hg^{2+}$in real water samples.

**Keywords:** Colorimetric sensor, (NiO-g-$C_3N_4$), Tetramethyl benzidine, Cysteine, Mercury

# HARNESSING MARINE BY-PRODUCTS FOR GREEN NANOTECHNOLOGY: COPPER OXIDE NANOPARTICLES FROM SEA URCHIN SPINES FOR SUSTAINABLE CROP PROTECTION

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This study presents a sustainable approach to synthesizing copper oxide nanoparticles (CuONPs) using zoochemicals extracted from sea urchin *Salmacis virgulata* spines, a readily available marine waste resource. The synthesis of copper oxide nanoparticles (Z-CuONPs) using sea urchin (*Salmacis virgulata*) spine extract successfully produced stable, spherical nanoparticles with an average size ranging from 10 to 80 nm, confirmed through multiple characterization techniques including UV-Vis, FTIR, SEM, TEM, EDX, and XRD. The aqueous extract contains over 60 bioactive zoochemicals that acted effectively as reducing and capping agents during nanoparticle formation. Insecticidal assays demonstrated potent toxicity of Z-CuONPs and spine extract against *Tribolium castaneum* adults, with $LC_{50}$ values of 131.91 and 161.30 µg/mL, respectively, exhibiting dose-dependent mortality. Biochemical analysis revealed significant inhibition of glutathione S-transferase (GST) alongside elevated oxidative stress enzymes superoxide dismutase (SOD) and catalase (CAT), indicating the induction of reactive oxygen species and lipid peroxidation leading to cellular damage. Histopathological evaluations confirmed morphological damage in treated insect tissues. Furthermore, both treatments displayed effective antifungal activity against common storage pathogens such as *Aspergillus niger*.

Phytotoxicity tests demonstrated no negative effects on *Vigna radiata* seed germination or early growth at sublethal doses, with slight stimulation of root elongation by Z-CuONPs. These results highlight the dual functionality of marine waste-derived Z-CuONPs as eco-friendly insecticidal and antifungal agents with minimal risk to crop health, providing valuable insight for sustainable pest and disease management practices.

**Keywords:** Zoochemicals, Sea urchin, *Salmacis virgulata*, Nanoparticles, CuONPs, Insecticidal.

# NANO-ACHE INHIBITOR OF GREEN SYNTHESIZED AGNPS USING *GARCINIA SPICATA*: A DUAL APPLICATION OF MOSQUITO LARVICIDE AND VIRAL INFECTION CONTROL

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Acetylcholinesterase (AChE) enzyme is a primary key of insecticide development. The target of the AChE enzyme inhibitor is to be used to control acetylcholine (ACh) substrate hydrolysis, which responds to increased ACh substrate to stimulate insect toxicity. Nowadays, globally, green nanotechnology is a remarkable approach to insecticidal development with the advantages of low cost, eco-friendliness, specific targeting, and less environmental toxicity. The present aim explored the nano-AChE inhibitor of green synthesized AgNPs using *Garcinia spicata* bioactive compounds against dengue vector *Aedes aegypti* larvae. *Garcinia spicata* aqueous extract is involved in silver iron ($Ag^{+}$) reducing and capping agent to the formation of silver atoms ($Ag^{0}$) as silver nanoparticles (AgNPs), which significantly contribute to the presence of polyphenols, flavonoids, alkaloids, and terpenoid bioactive compounds. The characterization techniques of UV-visible, FTIR, and SEM were confirming the synthesis of AgNPs. The AgNPs and *Garcinia spicata* extract had a potential *in vitro* AChE enzyme inhibition ($IC_{50}$ = 90.03 and 110.22 µg/mL) in a dose-dependent manner ($R^2$ = 0.9). *Garcinia spicata*-AgNPs are responsive to the ACh substrate stimulator in target *Aedes aegypti* larvae with a direct impact on larvae toxicity by the mode of AChE inhibition. According to our findings, there is a potential source of green nanotechnology for mosquito control application and impact on controlling dengue viral infection and an alternative to synthetic drugs.

**Keywords:** Nano-AChE inhibitor, AgNPs, *Garcinia spicata*, insecticide, Mosquito control.

**PP 44**

# GREEN SYNTHESIS OF COPPER OXIDE NANOPARTICLES AND FORMATION OF COMPOSITE WITH SCHIFF BASE FOR THE APPLICATION OF CORROSION INHIBITION FOR MILD STEEL

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The present study is aimed to find a suitable alternative for traditional and hazardous corrosion inhibitors. CuO was prepared by green methodology, then it was composite with Schiff's base for the application of corrosion inhibition of mild steel. Synthesized CuO-SB composite was characterized by following techniques UV, FT-IR and XRD. CuO-SB coated on mild steel and the corrosion studies examined by Weight Loss Method. The results indicated that CuO-SB composite exhibited superior mixed-type corrosion protection to mild steel at different time, pH and concentration of inhibitors owing to the formation of compact and ordered CuO-SB composite adsorption on mild steel surface.

**Key Words:** CuO, Schiff's Base, Composite, mild steel.

**PP 45**

# RAPID SYNTHESIS OF EXFOLIATED GRAPHITE FOR OUTSTANDING ENVIRONMENTAL APPLICATIONS

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Industrialization, though essential for global development, also leads to environmental pollution, mainly water resources contaminated by industry-released organic pollutants such as dyes, heavy metal ions, and chemical leakages and spilled oils. Air pollution is essentially caused by $CO_2$ emissions from automobiles, and electromagnetic radiation is caused by vast usage of electronic devices. Here we prepared well exfoliated graphite in about one minute, providing an extraordinary performance in mitigating all the above-mentioned pollutants. It rapidly removes a variety of organic pollutants and heavy metal ions under aqueous solutions. A high EMI shielding effectiveness of approximately 95-82 (-dB) was obtained in the broad frequency region of 6-18GHz. All the experiments were repeated a number of times for consistency of the results.

# LOW-COST ACTIVATED CARBON SYNTHESIZED FROM GULMOHAR SEEDS FOR THE REMOVAL OF XYLENOL ORANGE FROM AQUEOUS SOLUTIONS: KINETIC, EQUILIBRIUM, AND THERMODYNAMIC INVESTIGATIONS

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An inexpensive, highly porous activated carbon (AC) was produced from matured Gulmohar (Delonix regia) seeds using sulfuric acid as the activating agent. This activated carbon was then applied for the adsorption of Xylenol Orange (XO) from aqueous solutions. Batch experiments were carried out to optimize key operational parameters, and the resulting AC material was characterized using SEM and FT-IR analyses.

**Keywords:** Activated carbon, Gulmohar, Xylenol Orange, adsorption, SEM, FT-IR.

**PP 47**

# STUDIES ON RARE, ENDANGERED, THREATENED CLIMBER SPECIES OF TROPICAL DRY EVERGREEN FORESTS (TDEFS) ON THE COROMANDEL COAST OF INDIA

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Tropical dry evergreen forests (TDEFs) on the Coromandel Coast of Peninsular India are experiencing fragmented distribution and decline. This study examines the climber species and their conservation status in two TDEF sites in Tamil Nadu: Thirumanikuzhi in Cuddalore district and Vellaripet in Villupuram district. These two villages were floristically surveyed to determine the extant climber diversity through regular field explorations and observations during the year 2018. This floristic survey resulted in documentation of climber species including a few lianes, representing families.

The most represented families were Meliaceae, Rutaceae, and Verbenaceae, each contributing two species, while Arecaceae, Barringtoniaceae, and Moraceae each contributed one species. In Vellaripet, dominant species include *Strychnos nux-vomica*, *Atalantia monophylla*, and *Lepisanthes tetraphylla*, whereas in Thirumanikuzhi, key species are *Memecylon umbellatum*, *Tricalysia sphaerocarpa*, and *Pterospermum canescens*.

The plant diversity in the region faces various threats from excessive grazing, overcollection of wild populations, and anthropogenic pressures such as developmental activities, urbanization, aquaculture farming, road construction, pollutions, land-use changes, encroachments and agricultural expansion. Despite the reported diversity in pertinent literature, the actual forest conditions show considerable decline in these areas. Conservation efforts must integrate traditional knowledge with ecological studies to effectively mitigate these threats.

**Keywords**: woody species; medicinal plants; tropical dry evergreen forests; traditional knowledge

**PP 48**

# MANGROVES OF TAMIL NADU – THE PAST, PRESENT AND FUTURE

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Mangroves, also known as mangals, are unique heterogenous group of salt-tolerant trees and shrubs that form dense forests in tropical and subtropical intertidal zones were freshwater mixes with seawater. Eumangroves or "true mangroves", plant species that are exclusively found in mangrove habitats, while mangrove associates are plants found in the same general ecosystem but can also thrive in other environments. They are one of the earliest evolved tree species and fossil wood and pollens dating back to c.25 million years ago of paleobotanical genera such as *Barringtonia,Cynometroxylon, Pemphis, Lumnitzera, Sonneratia*, etc. were found in Neogene flora of Pondicherry-Cuddalore Sandstone series & Neyveli lignite deposits.

India, with 7,526.6 km coastline spread across 9 coastal states, and 4 union territories, is represented by 125 eumangroves and its associates, which is about 56% of world's mangrove species. During the study on the floristic diversity of coastal Tamil Nadu (2010–2020), the current status and distribution of **25** eumangroves (15 genera & 13 dicot families; and 1 monocot species, and 1 gymnosperm species) were determined in the State. The tremendous loss of eumangroves and its associates (with loss of > 50% taxa) over the last three centuries in the coastal city of Chennai (Madras) brought to light, and the local extinction of mangrove species such as *Kandelia candel, Heritiera littoralis, Scyphiphora hydrophyllacea*, *Xylocarpus granatum*, *X. mekongensis*, *Soneratia apetala*, etc. in the region have also been revealed. Rhizophoraceae exhibits maximum diversity with 4 genera and 8 species in the region. There are around 70 mangrove associates in Tamil Nadu, the second largest state in terms of diversity of mangrove associates. The major threat factors influencing the mangrove habitats in the region were also identified and possible conservation measures to protect the extant taxa and promote the diversity of mangroves in the region are discussed.

# SYNTHESIS OF 4,4'-DIMETHOXY-1,2-DIPHENYLETHANE-1,2-DIONE AND STUDY OF ITS ANTIBACTERIAL ACTIVITY

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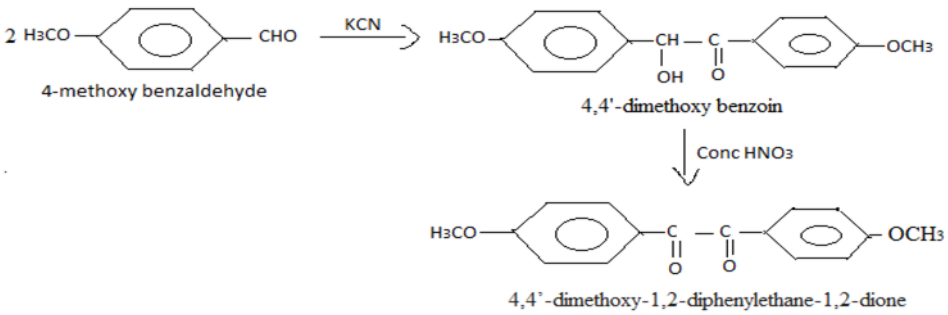
The compound 4-methoxy benzaldehyde when treated with potassium cyanide and on further steam distillation 4,4'-dimethoxy benzoin was synthesized. On oxidation of 4,4'-dimethoxy benzoin compound leads to the formation of 4,4'-dimethoxy-1,2-diphenylethane-1,2-dione. The yield of the tittle compound was good and their biological activity has been delineated. To obtain the pharmacological data molecular docking studies were conducted. The antimicrobial and cytotoxic activity of the compound 4,4'-dimethoxy-1,2-diphenylethane-1,2-dione was found to be higher. The MTT assay was used to determine the cytotoxic effects of the compound. The results showed that cell growth is significantly lower in extract treated cells compared to untreated control. For cytotoxic, anti-bacterial and anti-oxidant activity *in vitro* the cell growth inhibition effect was shown in different concentration dosages. The antibacterial activity of the compound is confirmed to be high from the antimicrobial activity.




4-methoxy benzaldehyde

4,4'-dimethoxy benzoin

4,4'-dimethoxy-1,2-diphenylethane-1,2-dione

# GREEN SYNTHESIZED POLYCRYSTALLINE Zr/$Fe_3O_4$ DECORATED RGO NANOCOMPOSITES: CHARACTERIZATION AND ITS PHOTOCATALYTIC ACTIVITY

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For many years, research scientists have aided communities in their tremendous efforts towards environmental remediation. Due to their high physical and chemical stability, metal oxide nanoparticles (NPs) have been used as metal catalysts to remedy this issue. Natural extracts provide a great alternative to harsh chemical, efficient synthesis techniques and cost effective. Here, Zr/$Fe_3O_4$ modified rGO nanocomposites were synthesized via Kappaphycusalvarezii plant extract green method with efficient hot plate combustion method. The synthesized nanomaterials characterized by X-ray diffraction (XRD), energy dispersive X ray analysis (EDX), Fourier transform infrared (FTIR) spectroscopy. The shape and exceptional size of synthesized Zr/$Fe_3O_4$ modified rGO nanocomposites demonstrated using high resolution scanning electron microscopy (HRSEM) and transmission electron microscopy (HRTEM). UV–vis and Cyclic voltammetry confirmed the growth and band gap energies of Zr/$Fe_3O_4$ modified rGO nanocomposites were found to be excellent photocatalysts for the degradation of hazardous cationic textile dye waste (CTDW) collected from dyeing industry. Furthermore, antibacterial activity against Gram positive (Staphylococcus aureus) and Gram-negative (Escherichia coli) bacteria and also, evaluate the impedance analysis.

The results explained that the synthesis of $Zr/Fe_3O_4$ modified rGO nanocomposites were economically cheap when compared with conventional methods and the nanoparticles showed a high efficiency in the removal of hazardous textile dyes, in an eco-friendly manner. Thus we have projected a diverse approach for the green synthesis of $Zr/Fe_3O_4$ modified rGO nanocomposites, which is economical and that is extremely important in the present times for the removal of hazardous chemicals.


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