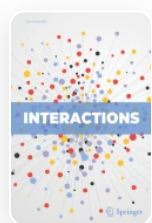


[Home](#) [Interactions](#) [Article](#)

Comprehensive insights on mechanical properties of natural-synthetic fibres with nano-graphene composite

Research Published: 11 May 2024

Volume 245, article number 82, (2024) [Cite this article](#)**Interactions**[Aims and scope](#)[Submit manuscript](#)**S. Jothi Arunachalam** , **R. Saravanan**, **T. Sathish** & **A. Parthiban** **149** Accesses  **2** Citations [Explore all metrics](#) →

Abstract

The primary purpose of this research was to look into the effect of silane treatment on the tensile and impact strength of composites constructed from Jute/kenaf/glass fibers with Nano-graphene filler. The research wanted to know how critical parameters in the treatment process, including silane concentration, immersion duration, and Nano-filler, may affect the composite characteristics. They used Response Surface Methodology (RSM) with Central Composite Designs (CCD) to perform their trials and enhance these aspects. The researchers built quadratic models that accurately predicted the tensile and impact strength of the Nano-composite during the Silane treatment. The researchers determined the best conditions for obtaining maximum tensile strength by varying silane concentration, immersion duration, and Nano-filler. The best ranges for silane

concentration and immersion duration were determined to be 15% wt. and 30 min, respectively. The impact strength of the composite increased by 36.20% under these conditions, while the use of 15% silane treatment for 30 min resulted in a 19.22% enhancement in tensile strength compared to the smallest values obtained by RSM optimization. These findings highlight the practical importance of Silane treatment, notably in increasing tensile and impact strength and strengthening the interfacial adhesive characteristics of natural fibres and polymer matrices.

 This is a preview of subscription content, [log in via an institution](#)  to check access.

Access this article

[Log in via an institution](#)

Subscribe and save

 Springer+ Basic

€32.70 /Month

Get 10 units per month

Download Article/Chapter or eBook

1 Unit = 1 Article or 1 Chapter

Cancel anytime

[Subscribe now](#) →

Buy Now

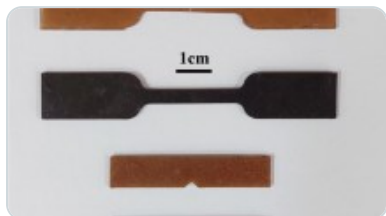
[Buy article PDF 39,95 €](#)

Price includes VAT (India)

Instant access to the full article PDF.

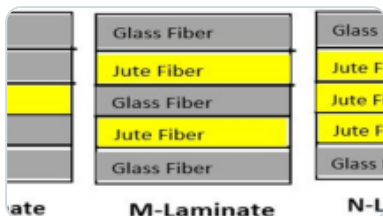
[Institutional subscriptions](#) →

Similar content being viewed by others



Evaluation of the effect of nanomaterials and fibers on the mechanical behavior o...

Article | 12 October 2022



Investigation of Tensile and Flexural Behavior of Green Composites along with their Impact...

Article | 10 September 2021



Experimental analysis of mechanical properties of graphene/kenaf/basa...

Article | 25 March 2021

Data availability

No datasets were generated or analysed during the current study.

References

1. Taghipoor, H., Mirzaei, J.: Statistical predicting and optimization of the tensile properties of natural fiber bio-composites. *Polym. Bull.* 80(12), 13217–13241 (2023). <https://doi.org/10.1007/s00289-023-04713-9>

[Article](#) [MATH](#) [Google Scholar](#)

2. Dhakal, H.N., Sain, M.: Thermal properties of Hemp Fiber-based hybrid composites. *Nat. Fiber-Reinforced Composites: Therm. Prop. Appl.* 183–200 (2022). <https://doi.org/10.1002/9783527831562.ch11>

3. Das, S.C., Paul, D., Grammatikos, S.A., Siddiquee, M.A., Papatzani, S., Koralli, P., Islam, J.M., Khan, M.A., Shauddin, S.M., Khan, R.A., Vidakis, N.: Effect of stacking sequence on the performance of hybrid natural/synthetic fiber reinforced polymer composite laminates. *Compos. Struct.* **276**, 114525 (2021).
<https://doi.org/10.1016/j.compstruct.2021.114525>

[Article](#) [Google Scholar](#)
4. Baraheni, M., Hoseini, A.M., Najimi, M.R.: Investigation on carbon fiber-reinforced polymer combined with graphene nanoparticles subjected to drilling operation using response surface methodology and non-dominated sorting genetic algorithm-II. *Proceedings of the Institution of Mechanical Engineers, Part E: Journal of Process Mechanical Engineering*, p.09544089241230160. (2024).
<https://doi.org/10.1177/09544089241230160>
5. Khalid, M.Y., Al Rashid, A., Arif, Z.U., Ahmed, W., Arshad, H., Zaidi, A.A.: Natural fiber reinforced composites: Sustainable materials for emerging applications. *Results Eng.* **11**, 100263 (2021). <https://doi.org/10.1016/j.rineng.2021.100263>

[Article](#) [Google Scholar](#)
6. Yorseng, K., Rangappa, S.M., Pulikkalparambil, H., Siengchin, S., Parameswaranpillai, J.: Accelerated weathering studies of kenaf/sisal fiber fabric reinforced fully biobased hybrid bioepoxy composites for semi-structural applications: Morphology, thermo-mechanical, water absorption behavior and surface hydrophobicity. *Constr. Build. Mater.* **235**, 117464 (2020).
<https://doi.org/10.1016/j.conbuildmat.2019.117464>

[Article](#) [Google Scholar](#)
7. Jagadeesh, P., Puttegowda, M., Boonyasopon, P., Rangappa, S.M., Khan, A., Siengchin, S.: Recent developments and challenges in natural fiber composites: A review. *Polym. Compos.* **43**(5), 2545–2561 (2022). <https://doi.org/10.1002/pc.26619>

[Article](#) [Google Scholar](#)

8. Ramesh, M., Maniraj, J., Kumar, S.G., Sahayaraj, A.F.: Physical Modification of Bast Fibre Surface and their effects. In: Bast Fibers and Their Composites: Processing, Properties and Applications, pp. 65–80. Springer, Singapore (2022).

https://doi.org/10.1007/978-981-19-4866-4_4 Nature Singapore

[Chapter](#) [MATH](#) [Google Scholar](#)

9. Yosr, B.M., Mounir, J., Foued, K., Slah, M., Durand, B.: Characterization and investigation of Tensile properties of Kenaf Fiber Reinforced Polyester Composite Material. J. Nat. Fibers. **19**(14), 8355–8366 (2022).

<https://doi.org/10.1080/15440478.2021.1964128>

[Article](#) [Google Scholar](#)

10. Jawaid, M., Chee, S.S., Asim, M., Saba, N., Kalia, S.: Sustainable kenaf/bamboo fibers/clay hybrid nanocomposites: Properties, environmental aspects and applications. J. Clean. Prod. **330** (2022). <https://doi.org/10.1016/j.jclepro.2021.129938>

11. Venkatasudhahar, M., Ravichandran, A.T., Dilipraja, N.: Effect of stacking sequence on mechanical and moisture absorption properties of abaca-kenaf-carbon fiber reinforced hybrid composites. J. Nat. Fibers. **19**(13), 7229–7240 (2022).

<https://doi.org/10.1080/15440478.2021.1944434>

[Article](#) [Google Scholar](#)

12. Niyaraki, M.N., Mirzaei, J., Taghipoor, H.: Evaluation of the effect of nanomaterials and fibers on the mechanical behavior of polymer-based nanocomposites using box–Behnken response surface methodology. Polym. Bull. **80**(9), 9507–9529 (2023). <https://doi.org/10.1007/s00289-022-04517-3>

[Article](#) [MATH](#) [Google Scholar](#)

13. Sumrith, N., Techawinyutham, L., Sanjay, M.R., Dangtungee, R., Siengchin, S.: Characterization of alkaline and silane treated fibers of 'water hyacinth plants' and reinforcement of 'water hyacinth fibers' with bioepoxy to develop fully biobased sustainable ecofriendly composites. *J. Polym. Environ.* **28**, 2749–2760 (2020). <https://doi.org/10.1007/s10924-020-01810-y>
14. Kandemir, A., Pozegic, T.R., Hamerton, I., Eichhorn, S.J., Longana, M.L.: Characterisation of natural fibres for sustainable discontinuous fibre composite materials. *Materials*. **13**(9) (2020). <https://doi.org/10.3390/ma13092129>
15. Owen, M.M., Achukwu, E.O., Akil, H.M., Romli, A.Z., Zainol Abidin, M.S., Arukalam, I.O., Ishiaku, U.S.: Effect of epoxy concentrations on thermo-mechanical properties of kenaf fiber–recycled poly (ethylene terephthalate) composites. *J. Ind. Text.* **52** (2022). <https://doi.org/10.1177/15280837221127441>
16. Shirke, M.B., Shelke, S.N.: November. Investigation on Mechanical properties of regular and Engineered Fiber built up Polymer composites. In: *Materials Science Forum*, vol. 1073, pp. 57–66. Trans Tech Publications Ltd. (2022). <https://doi.org/10.4028/p-nzhq8b>
17. Pirmohammad, S., Shokorlou, Y.M., Amani, B.: Influence of natural fibers (kenaf and goat wool) on mixed mode I/II fracture strength of asphalt mixtures. *Constr. Build. Mater.* **239** (2020). <https://doi.org/10.1016/j.conbuildmat.2019.117850>
18. Jothibas, S., Mohanamurugan, S., Vijay, R., Lenin Singaravelu, D., Vinod, A., Sanjay, M.R.: Investigation on the mechanical behavior of areca sheath fibers/jute fibers/glass fabrics reinforced hybrid composite for light weight applications. *J. Ind. Text.* **49**(8), 1036–1060 (2020). <https://doi.org/10.1177/1528083718804207>

[Article](#) [Google Scholar](#)

[Article](#) [Google Scholar](#)

19. Nor, A.F.M., Hassan, M.Z., Rasid, Z.A., Aziz, S.A.A., Sarip, S., Md Daud, M.Y.: Optimization on tensile properties of kenaf/multi-walled CNT hybrid composites with box-behnken design. *Appl. Compos. Mater.* **28**, 607–632 (2021)
- [Article](#) [ADS](#) [Google Scholar](#)
20. Nugroho, G., Budiyanoro, C.: Optimization of fiber factors on flexural properties for carbon fiber reinforced polypropylene. *Journal of Composites Science*, **6**(6), p.160. (2022)
21. Natrayan, L., Janardhan, G., Paramasivam, P., Dhanasekaran, S.: Enhancing Mechanical Performance of TiO₂ Filler with Kevlar/epoxy-based Hybrid Composites in a Cryogenic Environment. a statistical optimization study using RSM and ANN methods (2023)

Acknowledgements

The author thanks the management of Saveetha School of Engineering, SIMATS, for giving their extended support to complete the work.

Author information

Authors and Affiliations

Department of Mechanical Engineering, Saveetha School of Engineering, SIMATS, 602 105, Chennai, TN, India

S. Jothi Arunachalam, R. Saravanan & T. Sathish

Department of Mechanical Engineering, Vels Institute of Science, Technology and Advanced Studies (VISTAS), Chennai, TN, India

A. Parthiban

Contributions

S.J.A. and R.S. contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript. T.S. and A.P. wrote the paper

with input from all authors.

Corresponding author

Correspondence to [S. Jothi Arunachalam](#).

Ethics declarations

Ethical approval

Not applicable.

Consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Additional information

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Rights and permissions

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.

[Reprints and permissions](#)

About this article

Cite this article

Arunachalam, S.J., Saravanan, R., Sathish, T. *et al.* Comprehensive insights on mechanical properties of natural–synthetic fibres with nano–graphene composite. *Interactions* **245**, 82 (2024). <https://doi.org/10.1007/s10751-024-01921-1>

Accepted

01 May 2024

Published

11 May 2024

DOI

<https://doi.org/10.1007/s10751-024-01921-1>

Keywords

[Chemical treatment](#)

[Natural fiber](#)

[Nano–graphene](#)

[Tensile strength](#)

[Impact strength](#)