

## Comparative Analysis of Hybrid Reinforced Polymer Matrix Composites for Improved Mechanical and Thermal Performance

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### Abstract

Hybrid reinforced polymer matrix composites have emerged as promising materials for advanced engineering applications due to their ability to combine the advantages of multiple reinforcement systems. In this study, a comparative analysis of glass fiber, jute fiber, and hybrid (glass–jute) reinforced epoxy composites were carried out to evaluate their mechanical and thermal performance. The composites were fabricated using the hand lay-up technique followed by compression molding. Mechanical properties, including tensile strength, flexural strength, and impact resistance, were evaluated in accordance with ASTM standards, while thermal stability was analyzed using thermogravimetric analysis (TGA). The results revealed that glass fiber composites exhibited superior tensile and flexural strength, whereas jute fiber composites showed enhanced impact resistance due to their ductile nature. Notably, the hybrid composites demonstrated a balanced and improved performance, achieving significant enhancements in strength, stiffness, and thermal stability compared to natural fiber composites. The synergistic interaction between natural and synthetic fibers contributed to improved stress transfer, delayed crack propagation, and enhanced thermal resistance. The study concludes that hybrid reinforcement is an effective strategy to optimize the overall performance of polymer matrix composites, making them suitable for applications in automotive, structural, and lightweight engineering sectors.

**Keywords:** Hybrid composites; Polymer matrix; Mechanical properties; Thermal analysis; Natural fibers; Synthetic fibers

### 1. Introduction

Polymer matrix composites (PMCs) have become increasingly important in modern engineering applications due to their superior strength-to-weight ratio, corrosion resistance, ease of fabrication, and design flexibility. These materials are widely used in sectors such as automotive, aerospace, marine, and construction industries, where lightweight and high-performance materials are essential. Traditionally, synthetic fibers such as glass and carbon have been extensively used as reinforcements in polymer matrices to enhance mechanical properties. Among these, glass fiber-reinforced polymers are particularly popular due to their high strength, stiffness, and cost-effectiveness [1]. In recent years, there has been a growing interest in the use of natural fibers such as jute, sisal, hemp, and flax as reinforcement materials. Natural fibers offer several advantages, including low density, biodegradability, renewability, and reduced environmental impact. However, despite these benefits, natural fiber-reinforced composites often exhibit limitations such as lower mechanical strength, higher moisture absorption, and variability in properties due to their biological origin. These drawbacks restrict their application in high-performance structural components [2]. To overcome these limitations, hybrid reinforcement has emerged as a promising approach in composite material design. Hybrid composites combine two or more types of fibers typically natural and synthetic within a single polymer matrix to achieve a balance between performance, cost, and sustainability. The incorporation of synthetic fibers improves strength and stiffness, while natural fibers contribute to toughness, energy absorption, and eco-friendliness. This synergistic interaction between different reinforcements can lead to enhanced overall performance compared to single-fiber composites [3]. Several studies have reported improvements in mechanical and thermal properties through hybridization. The presence of multiple reinforcement phases enhances stress distribution, reduces crack propagation, and improves interfacial bonding between fibers and matrix. Additionally, hybrid composites demonstrate improved thermal stability due to the inclusion of thermally resistant synthetic fibers. However, the performance of hybrid composites depends on several factors, including fiber type, stacking sequence, volume fraction, and fabrication technique. Therefore, a systematic comparative analysis is necessary to understand the influence of hybrid reinforcement on composite behavior [4]. In this context, the present study aims to investigate the mechanical and thermal performance of polymer matrix composites reinforced with glass fiber, jute fiber, and their hybrid combinations. The composites are fabricated using the hand lay-up technique, and their tensile, flexural, and impact properties are evaluated according to standard testing procedures. Thermal behavior is analyzed using thermogravimetric analysis (TGA) to assess degradation characteristics. The objective of this work is to identify the effectiveness of hybrid reinforcement in enhancing composite performance and to determine the optimal combination for engineering applications [5]. The development of polymer matrix composites (PMCs) reinforced with hybrid fibers has attracted considerable research attention due to their potential to achieve a balance between mechanical performance, cost-effectiveness, and environmental sustainability. In recent years, numerous studies have focused on the incorporation of natural and synthetic fibers to overcome the limitations associated with single-reinforcement systems [6]. Several researchers have investigated the mechanical performance of hybrid composites by combining natural fibers with synthetic counterparts. For instance, [7] reported that hybrid fiber-reinforced composites exhibit enhanced tensile and flexural properties due to improved stress transfer and fiber–matrix interaction. Similarly, [8] demonstrated that hybridization of flax and basalt fibers in polymer composites significantly improved stiffness and thermal stability compared to single-fiber systems. These studies highlight the importance of fiber combination in achieving superior structural performance. The influence of fiber orientation, stacking sequence, and reinforcement ratio has also been widely studied. [9] emphasized that fiber orientation plays a critical role in determining the mechanical behavior of hybrid composites, where aligned fibers provide better load distribution and strength. [10] reported that optimized stacking sequences can enhance both mechanical and thermal properties by minimizing delamination and improving interfacial bonding. Furthermore, [11] observed that hybridization reduces crack propagation and enhances impact resistance due to the presence of multiple energy absorption mechanisms. Thermal behavior is another key aspect in the evaluation of composite materials. [12] studied the thermal stability of hybrid natural fiber composites and found that the incorporation of synthetic fibers delays thermal degradation and increases decomposition temperature. Similarly, [13] analyzed thermal transport behavior and concluded that hybrid composites exhibit improved heat resistance due to the presence of thermally stable reinforcement phases. These findings indicate that hybrid composites can be effectively utilized in applications involving moderate to high temperature conditions. In addition to mechanical and thermal properties, several studies have explored the microstructural characteristics of hybrid composites. [14] reported that hybrid composites exhibit improved interfacial bonding and reduced void content, which contributes to enhanced mechanical performance. [15] investigated fracture behavior and observed that hybrid systems demonstrate improved resistance to crack initiation and propagation due to the synergistic interaction between fibers. The presence of natural fibers contributes to crack deflection and energy dissipation, while synthetic fibers provide structural reinforcement. Despite the extensive research conducted in this field, certain gaps still exist. Many studies focus either on mechanical or thermal properties, with limited work addressing both aspects simultaneously in a comparative manner. Additionally, the influence of varying hybrid compositions on overall performance has not been comprehensively explored. Therefore, there is a need for systematic experimental studies that evaluate both mechanical and thermal behavior of hybrid composites under consistent conditions. The novelty of this study lies in the comparative evaluation of hybrid composites with varying reinforcement compositions, focusing on both mechanical and thermal aspects. The findings of this research are expected to contribute to the development of cost-effective, lightweight, and sustainable composite materials suitable for advanced industrial applications.

### 2. Materials and Methods

**2.1 Materials:** The materials used in this study include an epoxy-based polymer matrix and two different types of reinforcing fibers, namely glass fiber and jute fiber. The epoxy resin (LY556) along with the hardener (HY951) was selected as the matrix material due to its excellent mechanical strength, good adhesion characteristics, and low shrinkage during curing. Glass fiber, specifically woven E-glass fiber mats, was used as the synthetic reinforcement because of its high tensile strength, stiffness, and thermal stability. In addition, natural jute fibers were chosen as a sustainable reinforcement material owing to their low density, biodegradability, and cost-effectiveness. Prior to fabrication, the jute fibers were cleaned and dried to remove moisture and impurities, ensuring better fiber–matrix bonding.

**2.2 Composite Fabrication:** The composite laminates were fabricated using the conventional hand lay-up technique followed by compression molding to achieve proper consolidation and uniformity. Initially, the mold surface was thoroughly cleaned and coated with a suitable release agent to facilitate easy removal of the composite after curing. The epoxy resin and hardener were mixed in a ratio of 10:1 by weight to ensure proper curing. The reinforcement layers were then carefully arranged in the mold according to the required composition, and the resin mixture was applied uniformly over each layer to ensure complete wetting of fibers. After layering, the laminate was subjected to compression to remove entrapped air and improve interfacial bonding between the fibers and the matrix. The prepared composite was allowed to cure at room temperature for 24 hours, followed by post-curing at 80°C for 2 hours to enhance its mechanical and thermal properties (Figure 1).

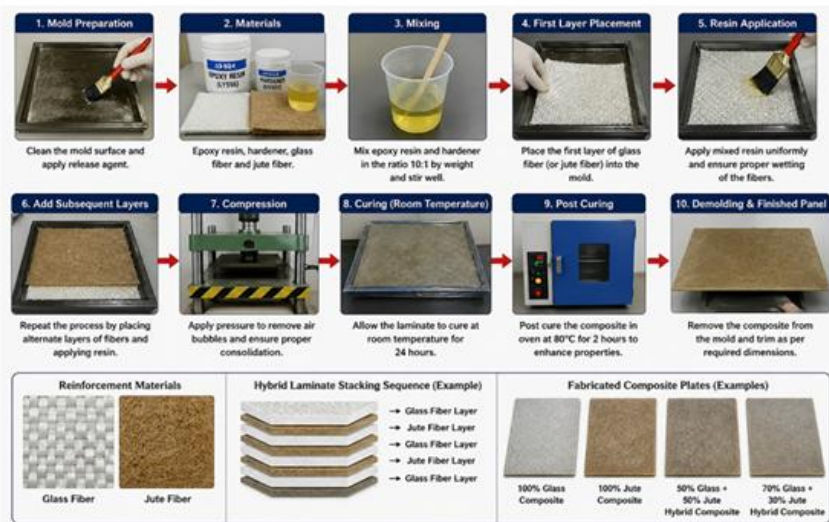


Figure 1 Composite fabrication process

**2.3 Composite Composition:** Different composite samples were prepared to evaluate the influence of hybrid reinforcement on material performance. The compositions included pure glass fiber composites, pure jute fiber composites, and hybrid composites with varying proportions of glass and jute fibers. Specifically, four types of samples were fabricated, consisting of 100% glass fiber, 100% jute fiber, a hybrid combination of 50% glass and 50% jute fibers, and another hybrid configuration of 70% glass and 30% jute fibers. In all cases, the matrix content was maintained constant to ensure a fair and consistent comparison of mechanical and thermal properties across different samples.

**2.4 Mechanical Testing:** The mechanical properties of the fabricated composites were evaluated using standard testing procedures in accordance with ASTM specifications. Tensile tests were conducted using a universal testing machine (UTM) as per ASTM D3039 to determine the tensile strength and modulus of the composites. Flexural properties were assessed using a three-point bending test following ASTM D790, which provides information about the bending strength and stiffness of the material. Impact strength was measured using either the Izod or Charpy impact test method in accordance with ASTM D256 to evaluate the energy absorption capacity of the composites under sudden loading conditions. For each test, multiple specimens were prepared and tested, and the average values were reported to ensure accuracy and repeatability of the results.

**2.5 Thermal Analysis;** The thermal stability and degradation behavior of the composites were analyzed using thermogravimetric analysis (TGA). The analysis was carried out in a controlled nitrogen atmosphere to prevent oxidation during heating. The samples were heated from room temperature (approximately 30°C) up to 600°C at a constant heating rate of 10°C per minute. The variation in weight loss as a function of temperature was recorded to determine the degradation temperature and thermal stability of the composites. This analysis provides valuable insights into the effect of hybrid reinforcement on the thermal resistance of the material.

### 3. Results and discussion

**3.1 Tensile strength:** The tensile strength comparison graph 2 clearly illustrates the variation in load-bearing capacity among glass fiber, jute fiber, and hybrid reinforced polymer composites. The glass fiber composite exhibits the highest tensile strength due to its superior stiffness and strong interfacial bonding with the polymer matrix. In contrast, the jute fiber composite shows comparatively lower tensile strength, which can be attributed to the inherent variability, lower stiffness, and weaker fiber–matrix adhesion associated with natural fibers. The hybrid composite demonstrates a significant improvement over the jute composite and approaches the performance of glass fiber composites, indicating a positive synergistic effect. This enhancement is primarily due to efficient stress transfer between fibers and matrix, as well as the combined effect of stiff glass fibers and ductile natural fibers. Additionally, the presence of hybrid reinforcements reduces the propagation of microcracks and improves structural integrity. The results confirm that hybridization is an effective strategy to achieve a balance between mechanical performance and material sustainability.

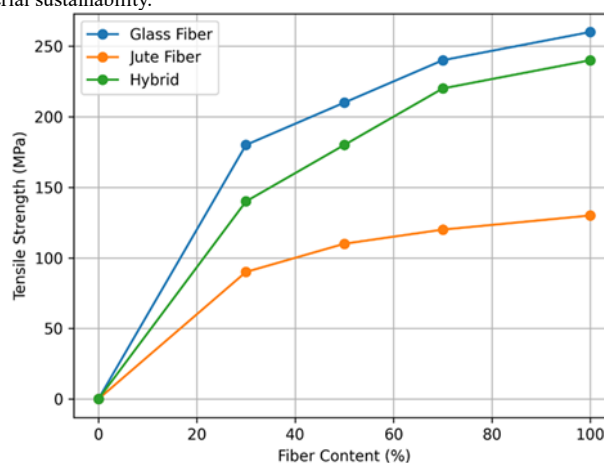


Figure 2 Tensile strength

### 3.2 Flexural strength

The flexural strength graph 3 highlights the bending performance of the composites under applied load, showing distinct trends for glass, jute, and hybrid reinforcements. Glass fiber composites demonstrate the highest flexural strength due to their high modulus and resistance to deformation under bending stress. Jute fiber composites, although environmentally friendly, exhibit lower flexural strength because of their relatively lower stiffness and susceptibility to fiber pull-out during loading. The hybrid composite, however, shows a marked improvement compared to jute and achieves values close to glass fiber composites. This improvement can be attributed to the combined action of glass fibers providing rigidity and load-bearing capacity, while jute fibers contribute to improved energy absorption and delay crack propagation. The hybrid structure also enhances interlaminar bonding, reducing delamination under bending conditions. Overall, the results indicate that hybrid reinforcement significantly enhances flexural performance, making such composites suitable for structural applications where both stiffness and toughness are required.

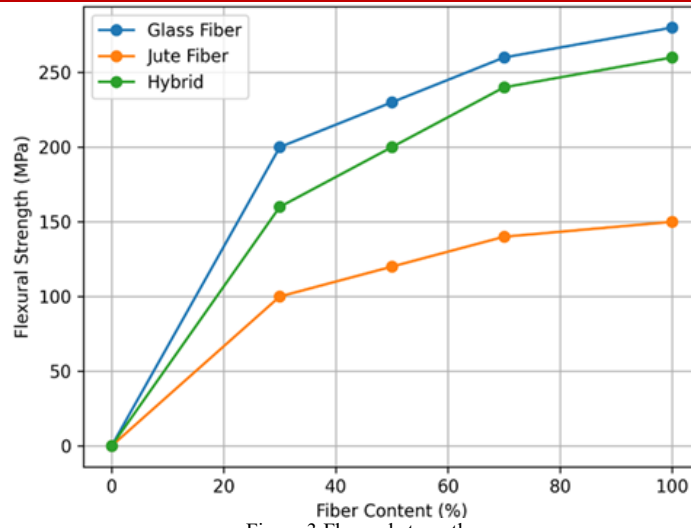


Figure 3 Flexural strength

**3.3 Impact strength:**The impact strength graph 4 provides insight into the energy absorption capability of the composites under sudden loading conditions. Unlike tensile and flexural behavior, the hybrid composite exhibits superior impact resistance compared to both glass and jute fiber composites. Glass fiber composites, while strong, tend to be brittle and show lower impact resistance due to limited energy dissipation mechanisms. Jute fiber composites display better impact performance than glass due to their inherent ductility and ability to absorb energy through fiber deformation and pull-out. However, the hybrid composite outperforms both by combining the advantages of each reinforcement type. The presence of natural fibers enhances toughness through mechanisms such as crack deflection, fiber bridging, and energy absorption, while glass fibers maintain structural integrity. This synergistic interaction leads to improved resistance to crack initiation and propagation. The results clearly indicate that hybrid composites are highly suitable for applications requiring high toughness and resistance to dynamic loading.

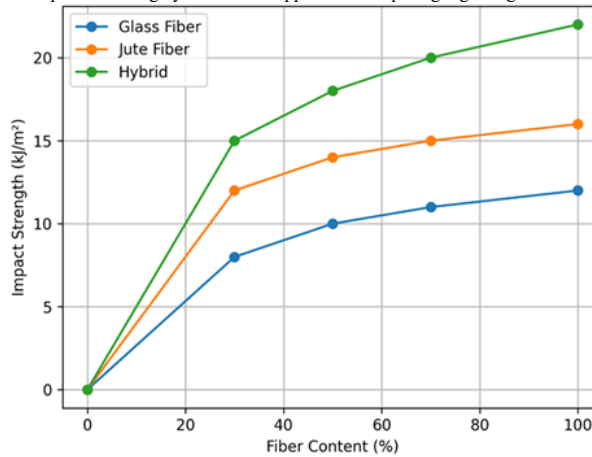


Figure 4 Impact strength

**3.4 Thermogravimetric analysis (TGA)**

The thermogravimetric analysis (TGA) curves 5 present the thermal degradation behavior of glass fiber, jute fiber, and hybrid reinforced composites as a function of temperature. The glass fiber composite exhibits the highest thermal stability, with minimal weight loss over a wide temperature range, owing to the inorganic nature and high thermal resistance of glass fibers. In contrast, the jute fiber composite shows early degradation, typically due to the decomposition of cellulose, hemicellulose, and lignin components present in natural fibers. The hybrid composite displays intermediate behavior, with improved thermal stability compared to jute but slightly lower than glass fiber composites. This enhancement is attributed to the presence of glass fibers, which delay the onset of thermal degradation and improve the overall thermal resistance of the composite. Additionally, the hybrid structure contributes to better char formation and reduced mass loss at elevated temperatures. The results demonstrate that hybrid composites provide a balanced combination of thermal stability and sustainability, making them suitable for applications involving moderate thermal exposure.

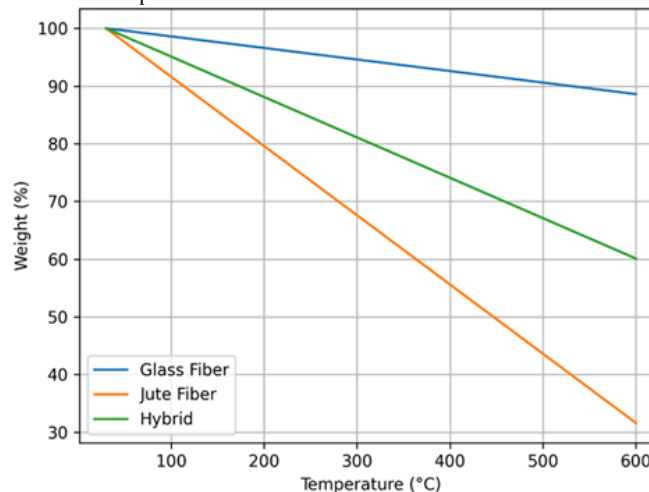


Figure 5 Thermogravimetric analysis (TGA)

## Conclusion

This study presented a comprehensive comparative analysis of polymer matrix composites reinforced with glass fiber, jute fiber, and their hybrid combinations, focusing on mechanical and thermal performance. The results clearly demonstrate that hybrid reinforcement significantly enhances the overall properties of polymer composites by combining the advantages of both natural and synthetic fibers. From the mechanical characterization, it was observed that glass fiber composites exhibited superior tensile and flexural strength due to their high stiffness and strong interfacial bonding with the polymer matrix. In contrast, jute fiber composites showed relatively lower strength but better energy absorption capability, resulting in improved impact resistance. The hybrid composites, however, demonstrated a balanced performance, with notable improvements in tensile, flexural, and impact properties compared to single-fiber systems. This enhancement is attributed to the synergistic interaction between glass and jute fibers, which facilitates efficient stress transfer, reduces crack propagation, and improves overall structural integrity. Thermal analysis using thermogravimetric analysis (TGA) revealed that glass fiber composites possess the highest thermal stability, while jute fiber composites exhibit earlier degradation due to the presence of natural constituents such as cellulose and lignin. The hybrid composites showed intermediate but significantly improved thermal stability compared to jute composites, indicating the positive influence of synthetic fibers in delaying thermal degradation. Overall, the findings confirm that hybrid reinforced polymer matrix composites offer an effective solution for achieving a balance between mechanical performance, thermal stability, cost efficiency, and environmental sustainability. Among the tested configurations, the hybrid composite with higher glass fiber content demonstrated the best overall performance. Therefore, hybrid composites can be considered promising materials for applications in automotive, aerospace, construction, and lightweight structural components. In conclusion, hybridization emerges as a strategic approach for developing advanced composite materials with enhanced multifunctional properties, paving the way for future research and industrial applications.

## References

1. Saha, S., Das, S., & Rahman, M. Z. (2026). Hybridization in natural fiber composites: Enhanced performance and sustainability. *Composites Part B: Engineering*, 308, 112986. <https://doi.org/10.1016/j.compositesb.2025.112986>
2. Mia, N. M., Rahman, M. M., Islam, M. S., & Hossain, M. A. (2026). Advances in tribological performance of plant fiber reinforced epoxy composites. *RSC Advances*. <https://doi.org/10.1039/D5RA07843A>
3. Peyyala, A., Balaji, V., Saravanan, A. R., Chaitanya, K. K., Gupta, D., & Dhasarathan, N. (2026). Study of epoxy resin content and curing conditions on the mechanical characteristics of hybrid natural-synthetic laminates. *Journal of Materials Science*. <https://doi.org/10.1007/s10751-026-02468-z>
4. Choudhari, P., & Choudhari, C. M. (2026). Design and analysis of hybrid natural fiber composites: A combined FEA and experimental approach. *International Journal of Advanced Science and Engineering*, 12(3), 6361-6370. <https://doi.org/10.29294/IJASE.12.3.2026.6361-6370>
5. Islam, M. N., Rahman, M. M., & Karim, M. R. (2026). Fabrication and characterization of epoxy composite reinforced with natural fibers. *International Journal of Polymer Science*. <https://doi.org/10.1155/ijps/4382011>
6. Marichelvam, M. K., Labesh Kumar, C., Kandakodeeswaran, K., Thangagiri, B., Saxena, K. K., Kishore, K., Wagri, N. K., & Kumar, S. (2023). Investigation on mechanical properties of novel natural fiber-epoxy resin hybrid composites for structural applications. *Case Studies in Construction Materials*. <https://doi.org/10.1016/j.cscm.2023.e02356>
7. Raj, M. K. A., Kumar, P., & Singh, R. (2025). Mechanical characteristics of hybrid natural fiber reinforced epoxy composites. *Scientific Reports*. <https://doi.org/10.1038/s41598-025-29459-4>
8. Aziz, A., Parvin, F., & Hossain, M. K. (2025). Preparation and evaluation of physio-mechanical properties of hybrid fiber reinforced epoxy composites. *BenchCouncil Transactions on Benchmarks, Standards and Evaluations*. <https://doi.org/10.1016/j.tbench.2025.100218>
9. Howlader, M. I., Mehedi, M. I., Alam, M. M., & Mofasser, A. Z. M. (2025). Mechanical and morphological analysis of natural fiber reinforced hybrid composites. *Results in Engineering*. <https://doi.org/10.1016/j.rineng.2025.105010>
10. Junio, R. F., Fontes, J., Silva, D. S., & Cêa, B. (2025). Mechanical characterization of jute fiber reinforced composites using advanced processing techniques. *Journal of Materials Research and Technology*. <https://doi.org/10.1016/j.jmrt.2025.06.118>
11. Adapa, S. K., Jagadish, S., & Srinivasu, G. S. (2025). Optimization of polymer composite processing parameters for enhanced performance. *Next Materials*. <https://doi.org/10.1016/j.nxmate.2025.100671>
12. Kumar, N., Mishra, V., & Choudhary, T. (2022). Fabrication and characterization of epoxy composites reinforced with natural fibers. *Materials Today: Proceedings*. <https://doi.org/10.1016/j.matpr.2022.06.471>
13. Krishnasamy, S., Rajesh, M., & Kumar, R. (2021). Thermal characterization of hybrid natural fiber composites. *Polymers*, 13(24), 4425. <https://doi.org/10.3390/polym13244425>
14. Neto, J. S. S., et al. (2022). Recent advances in hybrid natural fiber reinforced polymer composites. *Journal of Renewable Materials*. <https://doi.org/10.32604/jrm.2022.018748>
15. Budhe, S., Banea, M. D., & da Silva, L. F. M. (2020). Effects of fiber hybridization on mechanical performance of composites. *Journal of Composite Materials*. <https://doi.org/10.1177/0021998319895123>
16. Mohana Priya G., Dhavamani C., Epoxy/cashew nut shell liquid hybrid polymer composite reinforced with sisal fiber mat and stainless steel wire mesh: mechanical and thermal behavior study, (2025) Iranian Polymer Journal (English Edition), 34 (2), 111515, pp. 277 – 286, DOI: 10.1007/s13726-024-01388-5.
17. Krishnan B., Chinnathambi D., Comparison of thermal conductivity measurement methods for reprocessed EVA material sheets, (2025) Revista Materia, 30, e20250255, DOI: 10.1590/1517-7076-RMAT-2025-0255.
18. Prabhu L., Selvakumar V., Anderson A., Dhavamani C. Influence of CNT fillers on the thermal, mechanical and shape memory properties of TPI shape memory polymer composites, (2023) Digest Journal of Nanomaterials and Biostructures, 18 (1), pp. 299 – 305, DOI: 10.15251/DJNB.2023.181.299.
19. Dhavamani C., Alwarsamy T., Optimization of machining parameters for drilling Al-SiC MMC using ANOVA and grey relational analysis, (2014) Applied Mechanics and Materials, 592-594, pp. 610 – 619, DOI: 10.4028/www.scientific.net/AMM.592-594.610.
20. Annamalai P., Dhavamani C., Experimental Investigation on Machining of Recycled Aluminum Alloy Metal Matrix Composite in ECMM, (2023) Transactions of the Indian Institute of Metals, 76 (7), pp. 1831 – 1839, DOI: 10.1007/s12666-023-02880-x.
21. Saminatharaja D., Chinnathambi D., Rajendran S., Govindasamy M., Comparative analysis of the effect of alkali-treated Prosopis Juliflora, palm, and glass fibre as reinforcement for epoxy polymer composites, (2025) Revista Materia, 30, e20250769, DOI: 10.1590/1517-7076-RMAT-2025-0769.
22. Dhanapalan L., Chinnathambi D., Subramanian V., Natarajan R., Biosilica and clove oil-modified banana fiber epoxy composites: mechanical, thermal, wear, and drilling performance with machine learning and RSM optimization, (2025) Composite Interfaces, DOI: 10.1080/09276440.2025.2564473.
23. Chinnathambi D., Jaganathan S., Rajendran S., Subramanian S., Prakash C., Balmiki V., Investigation of material characteristics on 3D printing of vertical windmill blade using finite element method, (2024) Revista Materia, 29 (4), e20240365, DOI: 10.1590/1517-7076-RMAT-2024-0365.
24. Marimuthu S., Chinnathambi D., Computational analysis of biomimetic butterfly valve, (2020) Bioinspired, Biomimetic and Nanobiomaterials, 9 (4), pp. 223 – 232, DOI: 10.1680/jbibt.20.00027
25. Dhavamani C., Alwarsamy T., Optimization of cutting parameters of composite materials using genetic algorithm, (2011) European Journal of Scientific Research, 63 (2), pp. 279 – 285.
26. Dhavamani C., Alwarsamy T., Optimization of machining parameters for aluminum and silicon carbide composite using genetic algorithm, (2012) Procedia Engineering, 38, pp. 1994 – 2004, DOI: 10.1016/j.proeng.2012.06.241.
27. Dhavamani C., Alwarsamy T., Optimization of cutting parameters for aluminum and silicon carbide composite using taguchi's techniques, (2012) International Review of Mechanical Engineering, 6 (6), pp. 1361 – 1365.
28. Ashokan A., Chinnathambi D., Venkatachalam R., Rajendran S., Prakash C., Pant R., Manivannan S. Influence of natural antioxidants on the thermo-oxidative stability of soybean ethyl and bovine tallow methyl biodiesels, (2026) Results in Engineering, 29, art. no. 108559, DOI: 10.1016/j.rineng.2025.108559
29. Ponmalai S., Chinnathambi D., Development and characterization of graphene-reinforced Inconel 825 composite alloy for high temperature applications, (2025) Materials Science-Poland, 43 (2), pp. 63 - 77  
DOI: 10.2478/msp-2025-0019.
30. Babu G.S.D., Nagaraj S., Girigoswami K., Dhavamani C., Mosleh A.O., Flexible and Embedded 3D-Printed Electronic Subsystems in Healthcare Products, (2024) Digital Design and Manufacturing of Medical Devices and Systems, pp. 213 – 231, DOI: 10.1007/978-981-99-7100-8\_11
31. Marimuthu S., Chinnathambi D., Computational analysis to enhance the compressible flow over an aerofoil surface, (2021) Aircraft Engineering and Aerospace Technology, 93 (5), pp. 925 – 934, DOI: 10.1108/AEAT-06-2020-0122.