Editorial Corner

Eco-friendly Biocomposites: A Step Towards Achieving Sustainable Development Goals

Sathish Kumar Palaniappan, Manoj Kumar Singh, Sanjay Mavinkere Rangappa* and Suchart Siengchin
Natural Composites Research Group Lab, Department of Materials and Production Engineering, The Sirindhorn International Thai-German Graduate School of Engineering, King Mongkut's University of Technology North Bangkok, Bangkok, Thailand

* Corresponding author. E-mail: mavinkere.r.s@op.kmutnb.ac.th DOI: 10.14416/j.asep.2024.02.003

In recent years, eco-friendly sustainable composites have been in trend for innovative development in the area of materials science [1], [2]. The growing awareness of sustainable development and the high consumption of petroleum-based products leads to the development of new materials based on renewable resources. The development of novel, cutting-edge, eco-friendly materials has been encouraged by the new environmental standards with a broad range of applications including automobiles, packaging and construction industries [3]. The primary goal for sustainable development is to substitute natural resources for the present synthetic petroleum-based composites and contribute to reach environmental targets like reduction of greenhouse gas emissions, carbon footprint and attenuation of the impact of climate change. Biocomposites manufactured from natural resources are compostable, recyclable and biodegradable with similar characteristics as composites made of synthetic materials. Plant fibers and other renewable resources are being utilized to create biocomposite materials, which are gradually replacing traditional synthetic and non-biodegradable materials in various lightweight applications.

Natural fibers, such as flax, hemp, jute, sisal, wood, cotton, bamboo, silk, wool, feather, and so on; are essential to the development of environmentally friendly, sustainable biocomposites [4]. These renewable plant and animal fibers have a low carbon footprint, are recyclable, biodegradable, low-cost and produce less non-recyclable waste. The main chemical components of natural fibers are typically cellulose, hemicellulose and lignin. These substances can be utilized as filler material in the polymer matrix to create sustainable, environmentally friendly biocomposites that may be acceptable for a wide range of bulk industrial, biomedical and engineering applications. Natural fillers help to maintain the lightweight, thermally stable and sustainable qualities of green composites and improve their mechanical characteristics such as strength and stiffness. Natural fillers are important components in the manufacturing of sustainable green composites, greatly contributing to a greener and more sustainable future due to their exceptional performance, renewability, economics and eco-friendliness. Additionally, these sustainable composites enable new opportunities in advanced additive manufacturing, which offers promising solutions to prepare, process and manufacture [5]. Moreover, incorporating additive manufacturing impacts broad engineering applications [6].

Nowadays, in sustainable composites, numerical modeling and simulation are used along with artificial intelligence and machine learning to minimize the time and cost of experiments and to understand the various behavior of its constrictive elements [7]–[9]. Recycling of biocomposite is also one of the major contributors towards sustainable development goals. As one of the top producers of automobiles, Ford has been investigating and incorporating sustainable bio-based components into their products since the year 2000 [10]. The growing worldwide concern to reduce the adverse effects on the environment leads to a shift towards sustainable manufacturing methods. However, natural fiber-based biocomposites still face several challenges throughout the production process, including reduced impact strength, low durability, poor fire resistance, poor moisture absorption, poor interfacial adhesion and so on [11]. The extensive engineering applications of eco-friendly sustainable composites remain limited due to problems associated with material compatibility, mechanical characteristics

and post-processing procedures, despite substantial efforts have been made to develop innovative materials and manufacturing techniques. Research is going on for the enhancement of biocomposite properties so that it can be used in extensive engineering applications.

References

[1] R. Phiri, S. Mavinkere Rangappa, S. Siengchin, O. P. Oladijo, and H. N. Dhakal, "Development of sustainable biopolymer-based composites for lightweight applications from agricultural waste biomass: A review," *Advanced Industrial and Engineering Polymer Research*, vol. 6, pp. 436–450, 2023, doi: 10.1016/j.aiepr.2023.04.004.

[2] R. Phiri, S. M. Rangappa, S. Siengchin, and D. Marinkovic, "Agro-waste natural fiber sample preparation techniques for bio-composites development: Methodological insights," *Facta Universitatis, Series: Mechanical Engineering*, vol. 21, pp. 631–656, 2023, doi: 10.22190/FUME230905046P.

[3] M. M. Rahman, M. Maniruzzaman, and M. S. Yeasmin, "A state-of-the-art review focusing on the significant techniques for naturally available fibers as reinforcement in sustainable bio-composites: Extraction, processing, purification, modification, as well as characterization study," *Results in Engineering*, vol. 20, pp. 101511, 2023, doi: 10.1016/j.rineng.2023.101511.

[4] M. K. Singh, S. Siengchin, and S. M. Rangappa, "Recent advances of sustainable composites in manufacturing sector," *Journal of Applied Science, Engineering, Technology and Management*, vol. 1, no. 2, pp. 1–2, 2023.

[5] C. Billings, R. Siddique, B. Sherwood, J. Hall, and Y. Liu, "Additive manufacturing and characterization of sustainable wood fiber-reinforced green composites," *Journal of Composites Science*, vol. 7, no. 12, 2023, doi: 10.3390/jcs7120489.

[6] O. Koçar, N. Anaç, S. K. Palaniappan, M. Doğan, and S. Siengchin, "Effect of process parameters on the mechanical behavior of additively manufactured and FSW joined PLA wood sheets," *Polymer Composites*, vol. 45, no. 2, pp. 1568–1584, Jan. 2024, doi: 10.1002/pc.27874.

[7] A. I. Dmitriev, "Numerical model of a local contact of a polymer nanocomposite and its experimental validation," *Facta Universitatis, Series: Mechanical Engineering*, vol. 19, pp. 79–89, 2021, doi: 10.22190/FUME201225007D.

[8] K. Rohwer, "Models for Intralaminar damage and failure of fiber composites - A review," *Facta Universitatis, Series: Mechanical Engineering*, vol. 14, no. 1, pp. 1–19, 2016, doi: 10.22190/fume1601001r.

[9] A. Chichane, R. Boujmal, and A. E. Barkany, "A comparative study of analytical and numerical models of mechanical properties of composites and hybrid composites reinforced with natural reinforcements," *Polymers and Polymer Composites*, vol. 31, pp. 1–13, 2023, doi: 10.1177/09673911231172491.

[10] I. H. Chowdhury, M. A. Abdelwahab, M. Misra, and A. K. Mohanty, "Sustainable biocomposites from recycled bale wrap plastic and agave fiber: Processing and property evaluation," *ACS Omega*, vol. 6, no. 4, pp. 2856–2864, 2021, doi: 10.1021/acsomega.0c05186.

[11] M. Akter, M. H. Uddin, and I. S. Tania, "Biocomposites based on natural fibers and polymers: A review on properties and potential applications," *Journal of Reinforced Plastics and Composites*, vol. 41, no. 17–18, pp. 705–742, Feb. 2022, doi: 10.1177/07316844211070609.

Dr. Sathish Kumar Palaniappan
Research Scientist

Assoc. Prof. Dr. Sanjay Mavinkere Rangappa
Editorial Board

Dr. Manoj Kumar Singh
Research Scientist

Prof. Dr.-Ing. habil. Suchart Siengchin
Editor-in-Chief