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EDITED AND REVIEWED BY
Chuangang Hu,
Beijing University of Chemical Technology, China

*CORRESPONDENCE
Boon Peng Chang,
boonpeng.chang@ntu.edu.sg

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Editorial: Renewable biosourced carbon materials derived from biomass and their biocomposites fabrication for innovative applications

Boon Peng Chang[1]*, Xiangyu You[2], Jacek Andrzejewski[3] and Katarzyna Skórczewska[4]

[1]School of Materials Science and Engineering, College of Engineering, Nanyang Technological University, Singapore, Singapore, [2]College of Bioresources Chemical and Materials Engineering, Shaanxi University of Science and Technology, Xi'an, Shaanxi, China, [3]Institute of Materials Technology, Faculty of Mechanical Engineering, Poznan University of Technology, Poznan, Poland, [4]Bydgoszcz University of Science and Technology, Faculty of Chemical Technology and Engineering, Bydgoszcz, Poland

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Editorial on the Research Topic
Renewable biosourced carbon materials derived from biomass and their biocomposites fabrication for innovative applications

Carbon materials, renowned for their exceptional mechanical properties, thermal stability, and lightweight nature, have become indispensable in high-performance industries such as aerospace, automotive, and renewable energy. Among these, biomass-derived carbon materials—a unique subset of the carbon family—have garnered significant attention for their sustainability and versatility. These eco-friendly carbon materials, produced from renewable biomass sources, combine the advantageous properties of traditional carbon materials with the added benefits of environmental sustainability and cost-effectiveness.

Biomass-derived carbon materials offer immense potential to revolutionize advanced manufacturing processes, enabling the development of innovative solutions that reduce dependence on non-renewable resources. Their applications extend across diverse fields, driving progress in lightweight structural components, energy storage systems, and eco-conscious product design. By harnessing the untapped potential of these sustainable materials, industries can unlock transformative opportunities, paving the way for a greener, more sustainable, and inclusive future.

The Research Topic series "Renewable Biosourced Carbon Materials Derived From Biomass and Their Biocomposites Fabrication for Innovative Applications" encompasses a broad spectrum of studies dedicated to the development and application of renewable carbon-based materials.

The research conducted by Ji et al., focused on the development of activated biochar derived from corn stalks. The carbonization process utilized high-temperature pyrolysis followed by KOH activation. The primary objective was to create an efficient adsorption agent for petroleum hydrocarbons in groundwater. The resulting biochar significantly enhanced the effectiveness of nano zero-valent iron (nZVI) particles. The final adsorber, an iron/carbon composite, demonstrated improved stability and chemical reactivity compared to unmodified nZVI. Experimental tests confirmed the system's ability to effectively remove petroleum pollutants, such as crude oil, from contaminated water. This study underscores the utility of biochar's micro/nanoporous structure as an excellent carrier for reactive systems. Furthermore, the low cost and widespread availability of biomass feedstocks and biochar production facilities enhance the practicality of this approach.

Another significant contribution to the field was described by Dinu et al., who focused on the development of recyclable thermoset resins derived from biobased monomers. The synthesis process utilized triglycidyl ether of phloroglucinol (TGPh) or tris(4-hydroxyphenyl) methane triglycidyl ether (THPMTGE) monomers, combined with cross-linking agents such as hexahydro-4-methylphthalic anhydride (HMPA) and methyl nadic anhydride (MNA). Four distinct materials were synthesized and subjected to an extensive series of structural, mechanical, and thermal property evaluations. The results demonstrated the feasibility of developing eco-friendly, high-performance thermoset systems. Additionally, the cured materials exhibited depolymerization capabilities, making them suitable for recycling. This study highlights the potential to synthesize stable macromolecular structures, such as thermoset resins, using renewable and often non-toxic monomers. Importantly, the final products achieved comparable performance to conventional petrochemical-based materials, with a high proportion of bio-derived carbon structures in their composition.

Another innovative study, led by Mosqueda-Prado et al., explored the preparation of carbon quantum dots (CQDs) from nopal fiber residue. CQDs stand out among nanomaterials due to their unique optical and electrical properties, including controllable photoluminescence and high photostability. These characteristics make them ideal for applications in advanced technologies such as sensor production, bioimaging, and energy conversion. In this research, a CQD-titanium dioxide dispersion was used to modify nopal fabric, resulting in a pH-sensitive material. The results revealed that the CQD/TiO_2 system exhibited tunable optical properties and enhanced photostability. This preparation method holds promise for utilizing other types of agricultural waste, potentially developing efficient techniques for waste management while creating high-value nanomaterials.

In summary, the research presented in this series highlights the versatile potential of biomass-derived carbon materials. The Research Topic range from utilizing waste biomass as a pollutant adsorber to developing sustainable methods for renewable carbon-based thermosets and creating smart fabric materials enhanced with quantum carbon dot particles. Collectively, these studies illustrate that modern engineering materials can achieve high performance without relying heavily on petroleum-based resources. They also underscore the significant potential of green chemistry technologies to shape a more sustainable industry rooted in renewable resources and environmentally friendly synthesis methods. This emerging field promises to revolutionize material science while contributing to a circular economy and a more sustainable future.

Author contributions

BPC: Conceptualization, Formal Analysis, Project administration, Resources, Supervision, Validation, Visualization, Writing–original draft, Writing–review and editing. XY: Data curation, Formal Analysis, Investigation, Methodology, Validation, Writing–review and editing, Software. JA: Data curation, Formal Analysis, Investigation, Methodology, Validation, Writing–review and editing, Conceptualization, Visualization, Writing–original draft. KS: Data curation, Investigation, Software, Writing–review and editing.

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