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Letter from the Guest Editors

Focus Issue on Sustainable Manufacturing for Transportation

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In light of the growing concerns surrounding climate change and the increasing strain on our planet's finite resources, the pursuit of sustainable approaches in manufacturing vehicles and infrastructure related to transportation—the sector with the largest environmental footprint—is imperative. By incorporating environmentally conscious methodologies, such as the development of advanced lightweight materials, the implementation of energy-efficient technologies, and the adoption of waste reduction strategies, manufacturers can significantly reduce the carbon footprint and overall environmental impact of transportation systems. Advanced life cycle assessment (LCA) tools enable the comprehensive evaluation of environmental burdens associated with raw material extraction, production, usage, and end-of-life disposal, thereby identifying areas for improvement and facilitating informed decision-making. Furthermore, the integration of circular economy principles promotes material recovery and recycling, minimizing resource depletion and waste generation. The incorporation of digital technologies and new advancements in data analytics can further optimize manufacturing processes, improve energy management, and support the development of innovative transportation solutions. Ultimately, the adoption of sustainable practices in transportation manufacturing is not only vital for mitigating climate change and preserving finite resources but also instrumental in enhancing societal well-being, economic resilience, and global competitiveness in the emerging green economy.

This focus issue of the *SAE International Journal of Sustainable Transportation, Energy, Environment, & Policy* highlights pioneering research and reviews addressing diverse challenges in sustainable manufacturing. Contributions range from material innovations and manufacturing processes to energy efficiency and lifecycle sustainability in transportation and beyond. These articles collectively advance the understanding of how emerging technologies, advanced materials, and optimized methodologies can be applied to achieve environmentally and economically viable solutions. We hope this focus issue serves as a valuable resource for researchers, practitioners, and policymakers dedicated to advancing sustainability in the transportation sector.

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On lightweighting materials for automotive applications, Sai Aditya Pradeep et al. explored the development of graphene-filled polypropylene foams to achieve enhanced flexural properties while maintaining lightweight structures. Their study investigated the effects of graphene content and weight reductions, optimizing mechanical performance and cost-effectiveness. Additionally, the authors introduced a novel overmolding technique: combining foamed and solid polypropylene to improve flexural strength and modulus. The work highlighted the potential for significant fuel savings and reduced CO_2 emissions in automotive applications.

Conceptualizing the potential of upcycling plastic wastes, Mahdi Pirani et al. provided a comprehensive overview of converting waste plastics into carbon-capturing materials. The study explored carbonization and activation techniques and introduced a supercritical fluid-assisted injection molding process to create lightweight components with enhanced CO_2 absorption capacity. By addressing both plastic waste reduction and carbon sequestration, the authors proposed innovative solutions for sustainable transportation and construction.

Focusing on the sustainability aspects of structural batteries, Sambhaji Kashinath Kusekar et al. reviewed advancements in structural batteries that combined energy storage with load-bearing capabilities. The article delved into the multifaceted aspects of structural batteries, examining their dual function as energy storage devices and load-bearing components. The authors discussed significant advancements in materials, design innovations, and current manufacturing practices. By reviewing several case studies, the article highlighted the benefits of reduced weight, improved energy efficiency, and enhanced overall performance. However, the authors acknowledged critical challenges and emphasized the importance of optimizing material utilization, developing eco-friendly materials, and refining production processes to enhance sustainability. The study concluded with a call for collaborative efforts among industry, government, and academia to overcome these obstacles and realize the unique potential of structural batteries, especially in transportation.

On precision enhancement in 3D printing, Mahmoud Moradi et al. investigated methods to improve the dimensional accuracy and mechanical properties of polylactic acid (PLA) components for sustainable manufacturing. Using a systematic response surface methodology, the authors identified optimal processing parameters that minimized material waste and enhanced energy efficiency. The study showcased the potential of 3D printing in producing lightweight, high-performance parts for automotive applications.

On energy-efficient machining, Alper Başaran et al. evaluated strategies to reduce power consumption during the machining of nickel-based superalloys. The authors examined the effects of cutting speed, tool geometry, and cooling methods, including innovative cryogenic systems. Their findings offered actionable insights into optimizing energy use while maintaining high-quality machining outcomes, addressing both environmental and economic challenges in manufacturing.

Future studies in sustainable manufacturing could explore the integration of artificial intelligence and machine learning to optimize manufacturing processes dynamically. Further investigation into scalable recycling technologies, recyclable composites, and renewable energy integration into manufacturing facilities could bridge the gap between laboratory innovations and industrial applications. Moreover, interdisciplinary approaches connecting sustainable manufacturing with system lifecycle analysis and circular economy principles are essential to realizing a holistic framework for sustainability.

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