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BOOK OF ABSTRACTS



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A COMPREHENSIVE REVIEW OF BIO-INSPIRED SURFACE TRANSFER TECHNOLOGIES IN MECHANICAL METAMATERIALS FOR TRANSPORTATION APPLICATIONS

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Context: Significance of mechanical metamaterials in transportation:

Mechanical metamaterials, composed of polymers and polymer-based composites, play a pivotal role in addressing transportation challenges and facilitating new applications in the industry. The integration of these lightweight yet sturdy materials are expected to lead to improved fuel efficiency and regulatory compliance in the automotive sector, resulting in components with an enhanced strength-to-weight ratio. Additionally, these materials are increasingly being explored for their potential to ensure secure integration of electrical battery technology, boost payload capacity, and enhance structural integrity in aerospace and maritime transportation. Their incorporation has extended component lifespan by providing increased resistance to corrosion and wear, ensuring operational safety in various marine environments. Mechanical metamaterials are expected to optimize performance of transportation systems while promoting sustainability and safety.

Specific topic: Bio-inspired surface transfer:

Surface transfer (such as surface texturing) represents one key engineering solution for functionalizing polymers and composites, addressing the critical need for multi-functional materials in transportation. For instance, biomimetic textures inspired by shark skin reduce drag in marine vessels, while textures derived from bird feathers yield anti-fouling coatings. These textures facilitate the creation of self-cleaning surfaces for vehicle exteriors, enhancing visibility and safety in adverse weather conditions. Engineers and material scientists leverage these bio-inspired surface textures to develop sustainable solutions and address intricate challenges within the transportation sector.

Bio-inspired surface transfer technologies: Advancements versus challenges:

Bio-inspired surface transfer technologies, applied to polymers and polymer-based composites, aim to enhance aerodynamic performance, and reduce maintenance, presenting challenges related to precise texture replication, consistent texture fidelity, improved surface coverage, and scalability. The integration of machine learning and data-driven design accelerates the identification of optimal surface patterns, enhancing performance and durability in transportation applications. This integration streamlines the complex interplay between material properties, surface topography, and performance requirements, with the aim to accelerate the deployment of bio-inspired surface transfer technologies. These design approaches foster innovation and efficiency but require further development before contributing to sustainable and environmentally conscious transportation systems.

Surveying surface transfer technologies for bio-inspired textures in transportation:

This comprehensive survey explores the industrial and scientific significance of surface transfer technologies, focusing specifically on their application in generating bio-inspired textures for polymer-based materials. By leveraging innovative workflows, the study examines the role of bio-inspired textures in reducing friction and improving aerodynamics, highlighting their potential contributions to enhancing the sustainability of transportation systems. The survey critically addresses the practical limitations associated with these technologies, emphasizing the complexities in scaling up production and integrating these intricate textures into existing transportation infrastructure.

Evaluation of existing knowledge gaps related to bio-inspired surface textures:

This comprehensive study aims at highlighting the current understanding of bio-inspired surface textures and emphasizes the identification of existing knowledge gaps within this domain. By pinpointing areas of limited understanding, the survey study aims to pave the way for future research and development, fostering advancements in the utilization of bio-inspired surface textures for transportation applications.