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Multiscale Mechanics Design of Biodegradable Nano-Architected Materials: Toward a Sustainable Future

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ABSTRACT

Traditional materials are emerging increasingly severe problems such as environmental pollution, non-renewability, and resource waste. As the most abundant natural biomass in nature, nanocellulose materials are expected to become a new generation of green, biodegradable, high-performance structural materials and contribute to sustainable development. Starting from the intrinsic relationship between hydrogen bonding network and microstructure deformation in nanocellulose, we performs the bottom-up multiscale mechanics methods, combing theoretical modeling, experimental characterization and material preparation, to reveal the physical mechanism and key characteristic parameters of the microstructure-regulated mechanical behaviors of nanocellulose materials, further establishing the cross-scale relationship between hydrogen bonding, interfacial deformation and macroscopic mechanics [1, 4]. Through regulating the microstructural interface, the nanocellulose-based biomimetic structural materials with both strength/toughness and functionality will be designed [3, 5]. Then, we will try to promote the hydrolytic conversion of nanocellulose via introducing reasonable microstructure damage and defects, aiming to realize the high-efficiency and sustainable utilization of nanocellulose materials [6]. Facing the significant demand for high-performance structural materials and conversion methods in the field of biomedical engineering and sustainable development, our investigation is aimed at laying a theoretical foundation for the design, preparation and subsequent recycling/degradation of nanocellulose materials, exploring a new paradigm for rational design of advanced nano-architected materials from the interdisciplinary perspective of mechanics, materials and chemistry [2].

KEYWORDS

Nanocellulose; multiscale mechanics; interfacial deformation; microstructure regulation; mechanics design

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