# Design of Biopolymer Composite Films as High-Performance Sustainable Substitutes for Synthetic Plastics

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The replacement of synthetic plastics used in packaging, coatings and electronics with biodegradable alternatives made from sustainable naturally derived materials is a challenge of high societal importance. We report a class of high-performance multifunctional composite films made of nano- and micro-scale reinforced naturally sourced biopolymers. The films are made of agarose matrix and chitosan fibrils. We introduce a new reinforcing technique based on the unique properties of the soft dendritic colloids (SDCs) discovered and investigated by our group earlier (*Nature Mat.* 2019, *Nature Comm.* 2021). Owing to the highly entangled hierarchical network of the SDCs nanofibrils, the reinforced composite has excellent mechanical performance with more than four times higher toughness than non-reinforced agarose, high transmittance of visible light, high hydrostability, and remarkable bactericidal activity (*Cell Rep. Phys. Sci.* 2023). We also demonstrate the soil biodegradability of the films in natural environment Overall, these reinforced biopolymer composites have the potential to match or exceed the excellent mechanical, gas-barrier, and optical properties of common synthetic polymer films. The results suggest a universal strategy for manufacturing of natural-source composite materials that could serve as substitutes for petroleum-based plastics. The films can be additionally tailored by using bio-based plasticizers (*Adv. Electron. Mater.* 2024). Notably, not only these materials, but their manufacturing process can be environmentally friendly, as the whole process, including both the SDC fabrication and the film casting, can be water-based, facile, and scalable.