Sustainable Carbohydrate-Based Sizings: An Alternative for Glass and Basalt Fiber Surface Treatment

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Abstract

Fiber sizings are thin, multifunctional aqueous coatings applied to glass and basalt filaments directly after drawing, before the strands are bundled. They protect the fragile filaments from abrasion, provide lubrication and antistatic behavior, and ensure smooth handling during weaving or chopping. Equally important, they mediate adhesion between the inorganic reinforcement and the polymer matrix, governing the mechanical performance and durability of the final part. Conventional formulations rely on silane coupling agents, petroleum-based film formers (e.g., epoxy, polyurethane), and surfactants, contributing to fossil-resource consumption and to a notable footprint at the production stage through wastewater loads and worker exposure. Bio-based sizings derived from polysaccharides offer a more sustainable alternative by enabling fully aqueous, low-toxicity formulations from renewable feedstocks. While biodegradability is of limited relevance in classical thermoset composites, where the cured matrix shields the coating, it becomes highly attractive when the fibers are exposed to their surroundings or embedded in degradable systems. Typical examples include geotextiles, the reinforcement of natural building materials such as clay or lime-based mortars, fully bio-based composites with biopolymer matrices, and - in combination with bioresorbable glass fibers - medical devices. This work presents the development and characterization of bio-based sizings formulated with carbohydrate film formers, together with the resulting sized fibers and composites. The investigated systems are based on polysaccharides such as starch, alginates, and chitosan, chosen for their wide availability and proven film-forming ability. The characterization spans multiple length scales: at the formulation level, stability, viscosity, and processability are evaluated; at the fiber level, sized glass fibers are analyzed regarding coating morphology, sizing distribution, and single-filament mechanical properties; and at the composite level, the effect on fiber–matrix adhesion, mechanical performance, and durability is assessed. The contribution highlights the potential of polysaccharide-based sizings to combine processing performance, interfacial functionality, and sustainability in glass- and basalt-fiber-reinforced materials.

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