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Development of biopolymer-based composite fibers produced by the wet spinning technique

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Fiber-based materials have attracted increasing interest owing to their unique 1D structure, which enables the fabrication of lightweight, compact, and flexible devices for energy storage[1], strain sensing[2], and biomedical[3] applications. An interesting approach to produce these fibers is the wet spinning technique, which is based on the extrusion of a polymer solution through a spinneret into a nonsolvent mixture, leading to the formation of polymer fibers through coagulation. In this study, we developed a rotary wet spinning system by coupling 3D-printed components to a speed-controllable rotary motor, enabling the simple and rapid spinning of polysaccharide-based composite fibers. Specifically, sodium alginate (SA) and chitosan (CH) composite fibers were produced by adding fillers, such as carbon black, anthocyanins, and beta-chitin whiskers. For CH, the polymer was dissolved in a dilute aqueous acid solution, followed by direct extrusion into aqueous or hydroalcoholic NaOH solutions. The polymer was dissolved in distilled water and extruded into $CaCl_2$ solutions. The fillers used for the production of the composite fibers were directly added to the spinning dope solutions, which allowed the spinning of SA/anthocyanin, CH/carbon black, and CH/beta-chitin whisker composite fibers. For both CH and SA, the rotary wet spinning system allowed the production of uniform and continuous monofilaments with lengths of up to 2 m or greater. Moreover, the system enabled the spinning of the fibers directly into a deep eutectic solvent coagulation bath, which enhanced the ionic conductivity and freezing resistance of the fibers. The next steps of this work include the electrochemical, mechanical, and morphological characterization of the fibers produced so far, as well as the spinning of new formulations.

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