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Mechanically Drawing Polyacrylonitrile Nanofibers and Characterization of the Touchspinning Process

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Abstract

Polymeric nanofibers have been traditionally formed through the common electrospinning method. This method, while easy to run and efficient, includes dangerous drawbacks including the use of high voltage power supplies and the need for toxic polymer solvents. These drawbacks lead to further problems including limited mat collection and problems in processing complex natural polymers. Touchspinning is a brand-new method of nanofibrous mat formation. This method differs significantly from electrospinning in both its general set-up and the mechanism of fiber formation. The cold-drawing method of nanofiber formation by touchspinning utilizes a rotating disk with needles attached to it to "touch" a droplet of polymeric solution and pull this out, drying it in the process, to form a fiber. This process has been shown to be partially effective in biomedical application for neural stem cell proliferation, however the full analysis of its controllable parameters and their resultant fibers has not been conducted. Thus, the work presented here focuses on determining the full capabilities of the touchspinner to form nanofibers across varying controlled parameters and the parameters' effects on the final fibrous mat. The primary experiments explore the effects of polymer concentration, solution pump rate, and device rotation speed on both polymer nanofiber diameter and nanofibrous mat collection. Secondary results explore the further capabilities of the touchspinner to use complex and non-conductive substrates, demonstrate uninterrupted and significant collection rates, and evaluation of crystalline behavior within the nanofibrous mats. These results allow for a more full understanding of the touchspinning method and display the further capabilities of this method of polymer nanofiber fabrication.