EXTENSIONAL VISCOSITY IN ELECTROSPUN JET

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Electrospinning is a versatile method for the fabrication of nanofibers. In this method a liquid, typically a polymer solution, is introduced into a strong electrostatic field, where the charged solution is drawn out into a jet. Crucial to stabilization of the electrospun jet and avoiding the breakup of the filament into droplets is a sufficiently high extensional viscosity throughout the entire thinning. The source of this extensional viscosity is the focus of this work.

As an example we demonstrate the electrospinning of nanofibers composed entirely of a globular protein, bovine serum albumin (BSA), directly from a BSA solution without the use of chemical cross-linkers. Comprehensive rheological studies of the BSA solutions that can be electrospun into continuous fibers show an absence of any significant bulk elasticity in shear and extension that would account for the stabilization of the jet.

In order to explain this discrepancy, it is proposed that a complex jet structure, composed of a liquid core surrounded by a solidifying skin, is formed during the spinning process, where the skin's surface viscoelasticity is responsible for the jet stabilization. It is also shown that the surface viscoelasticity is further enhanced by varying the protein conformation (unfolding), as well as its concentration in solution. This stabilization mechanism is further exemplified for other electrospun polymer systems.