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Impact of Polydispersity on Polymer Solutions and Electrospun Nanofibers

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The extensional rheology of low-viscosity liquids is a field still in its infancy, yet it plays a critical role in numerous applications. One prominent example is the production of nanoscale fibers through electrospinning, where the rheological properties of polymer solutions are crucial for achieving consistent fiber formation and controlled morphologies. This study investigates the impact of polymer polydispersity on the rheological properties of solutions and their ability to produce electrospun nanofibers. Polymer blends with varying polydispersity but identical average molecular weights (Mw) were prepared using polystyrene (PS) dissolved in dimethylformamide (DMF) and polyethylene oxide (PEO) dissolved in water. The rheological behavior of these solutions was characterized using Capillary Breakup Extensional Rheometry (CaBER), and their processability was evaluated through electrospinning. Results demonstrate that solutions with higher polydispersity exhibit greater elasticity compared to those with narrower molecular weight distributions. Furthermore, electrospinning such solutions yielded nanoscale fibers of superior quality. This work underscores the critical role of elongational elasticity in producing high-quality nanofibers, which can be enhanced by increasing polymer polydispersity. Additionally, the CaBER rheometer proved to be an effective tool for optimizing the rheological properties of polymer solutions for electrospinning applications.