186e Linear Stability Analysis of Electrically-Driven, Viscoelastic Jets

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Electrospinning is a novel process forming polymeric fibres with submicron diameter through the action of electrostatic force. The key phase in this process is the region of jet instability, where massive jet elongation occurs. In the last annual meeting, we presented a model for the development of the initial stable electrospun jet and comparison with highly elastic Boger fluids. We now expand the model to allow the introduction of axisymmetric disturbances.

The stable jet model consists of a coupling of the laws of electrohydrodynamics (momentum equations and Gauss's Law) with viscoelastic polymeric constitutive equation (Oldroyd-B model). These coupled equations are solved numerically to establish a jet base state. Using the stable jet model as a basis, we then conduct linear stability analysis, which allows us to predict the onset of instability including the critical wavenumber of axisymmetric disturbance modes for an electrically driven, viscoelastic polymer jet.

Our results show the emergence of a new viscoelastic instability mode with a wavenumber significantly higher than those observed for classical capillary modes. We compare predicted critical conditions at the onset of instability with experimental data from the electrospinning of polymeric solutions.