ELECTROSPINNING

- Create nano-scale polymer fibers through the use of electric charge
  - Induce charge on polymer solution through applied voltage
  - When electrostatic forces overcome solution surface tension, a charged jet erupts from needle
- Normally undergoes 3 phases
  - Taylor Cone
  - Linear extension
  - Bending Instability
- Different collection methods based on desired orientation
- Current methods that yield oriented fibers are low output

ELECTROHYDRODYNAMIC MODELING

- Motivation: Numerous potential applications
  - Tissue scaffolds, multi-functional composites, filtration, sensors, drug delivery...
  - No model that can successfully link processing parameters with fiber diameter for multiple polymer-solvent systems!
- Helgeson et al. electrohydrodynamic model
  - Reduce dimensionless balance equations based on analogy to traditional uni-axial flow
    - Identify important forces in different sections of stable jet region
    - Experimentally verified for poly(ethylene oxide)-water system through high speed velocimetry

STABLE JET REGIONS

- Helgeson et al. electrohydrodynamic model
  - i. Taylor Cone
  - ii. Jet Initiation
    - Strain Hardening
    - Large increase in extensional viscosity
  - iii. Jet Stretching
    - Reach pseudo-steady state extensional viscosity
    - \( R \sim z^{1/2}, \ v \sim z \)
  - iv. Jet Thinning
    - \( R \sim z^{1/4}, \ v \sim z^{1/2} \)

HIGH SPEED IMAGING

- Goal: Explicitly verify observed scaling laws for a completely different electrospinning system
- Poly(ethylene oxide)-Chloroform
  - Linear jet—No bending instability!
- Collection of highly spatially oriented fibers

RADIUS FITTING

- \( R(z) = A z^n + B z^{-1/2} + C z^{-1/4} \)

VELOCITY PROFILE

- \( v = \frac{Q}{\pi \cdot (R(z))^2} \)

EXPERIMENTAL

- Goal: Explicitly verify observed scaling laws for a completely different electrospinning system
- Poly(ethylene oxide)-Chloroform
  - Linear jet—No bending instability!
- Collection of highly spatially oriented fibers

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