Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

**Finite Amplitude Stability Analysis of Polymer Fiber Spinning**

KARAN GUPTA, PARESH CHOKSHI, Indian Institute of Technology Delhi —

The spinning of polymeric fibers suffers from draw resonance instability, manifested by periodic variation of fiber diameter. This occurs when the draw ratio exceeds a certain critical value above which the extensional is unstable. In the present study, weakly nonlinear analysis is performed for polymer fiber spinning to estimate the nature of bifurcation and to construct the finite amplitude branch near critical point. For entangled polymers, we employ the eXtended Pom-Pom model which describes nonlinear rheology of polymer melt. The linear stability analysis provides the critical draw ratio as a function of fluid elasticity represented by Deborah number. In the unstable regime, the nonlinearities saturate the disturbance amplitude to an equilibrium value. Weakly nonlinear analysis is carried out to obtain the equilibrium amplitude along the neutral stability curve. The dynamical equation for the amplitude is the Landau equation with a Landau constant representing nonlinear growth rate. For flows at small $De$, the Landau constant is found to be negative, indicating supercritical bifurcation. The amplitude branch constructed shows a limit cycle behavior. As the fluid elasticity is increased, initially the equilibrium amplitude is found to decrease and reaches the lowest value when the strain hardening is maximum. Further increase in elasticity, the material undergoes strain softening behavior which leads to increase in amplitude of the oscillations. At very high $De$, the flow becomes subcritically unstable meaning the flow can become unstable below critical draw ratio.

Karan Gupta
Indian Institute of Technology Delhi

Date submitted: 01 Aug 2014 Electronic form version 1.4