Dynamics of associative polymer solutions: Capillary break-up, jetting and rheology

VIVEK SHARMA, Hatsopoulos Microfluids Laboratory, Dept of Mechanical Eng., MIT, Cambridge, MA 02139, JAMES G. SERDY, Laboratory of Manufacturing and Productivity, MIT, PHIL THREFALL-HOLMES, AkzoNobel, UK, GARETH H. MCKINLEY, Hatsopoulos Microfluids Laboratory, Mechanical Eng., MIT, Cambridge, MA 02139 — Associative polymer solutions are used extensively in the formulations for water-borne paints, food, inks, cosmetics, etc to control the rheology and processing behavior of multi-component dispersions. The commercially relevant formulations use dilute solutions of associative polymers, which have low viscosity and short relaxation times, and hence their non-Newtonian response is not apparent in a conventional rheometer. In this talk, we explore several methods for systematically exploring the linear and nonlinear solution rheology of associative polymer dispersions, including: high frequency oscillatory tests at frequencies up to 10 kHz, microfluidic shear rheometry at deformation rates up to $10^6$ s$^{-1}$ and the influence of transient extensional rheology in the jet breakup. The presence of inertial, elastic and viscous effects typically leads to complex dynamics in a necking fluid thread. We show that by carefully controlling the excitation frequency, it is possible to drive the break-up in a particularly simple and symmetric mode, which can be used to extract extensional viscosity information using capillary thinning analysis.

Vivek Sharma
Hatsopoulos Microfluids Laboratory, Dept of Mechanical Eng., Massachusetts Institute of Technology, Cambridge, MA 02139