ANNOUNCEMENT

Soft Matter Seminar Series

When: *Monday April 15, 2013 at 3:00 PM*

Where: ***ECE 101 (Lankford)***

Microfluidic Rheometry of Complex Fluids

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The development and growth of microfluidics has stimulated interest in the behavior of complex liquids in microscale geometries and provided a rich platform for rheometric investigations of non-Newtonian material phenomena at small scales. Microfluidic techniques present the rheologist with new opportunities for measurement of fluid properties, and enable the systematic investigation of strong elastic effects at very high deformation rates without the complications of fluid inertia. In this presentation we provide an overview of the use of microfluidic devices to measure bulk rheology and onset of viscoelastic flow instabilities in both shear and extensional flows, using a combination of local velocimetric imaging, mechanical measurements of pressure drop and full-field optical probes of flow-induced birefringence. Steady and time-dependent flows of a range of dilute polymer solutions and wormlike micellar fluids are considered. The ability to rapidly and precisely fabricate complex flow geometries also enables us to exploit the predictions of computational optimization and design, from first principles, an optimized shape cross-slot extensional rheometer (or OSCER) that achieves homogeneous planar extensional kinematics and large fluid strains. Local birefringence measurements along the stagnation streamlines, combined with bulk measurements of the excess pressure drop across the device, provide self-consistent estimates of the extensional viscosity over a wide range of deformation rates up to 1000 s-1. The results are also in close agreement with numerical simulations based on a finitely extensible non-linear elastic (FENE) dumbell model. As the imposed extension rate in the OSCER device is increased the homogeneous planar elongational flow ultimately becomes unstable. High-frame rate video-imaging of the birefringence field is used to construct space-time diagrams of the evolution in the flow for seven different polymer solutions and to construct the first stability diagram for planar extensional flows in cross-slot devices. The mode of instability is found to depend on the elasticity number (El = Wi/Re) of the fluid, with a steady symmetry-breaking purely-elastic bifurcation observed at high El >> 1, and time-dependent three-dimensional inertio-elastic instabilities dominant for El < 1

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