Abstract Submitted
for the DFD09 Meeting of
The American Physical Society

Visualization and microrheology of complex fluid/fluid interfaces

SIYOUNG Q. CHOI, JOSEPH ZASADZINSKI, TODD SQUIRES, UCSB Chemical Engineering — We describe a novel microrheological technique to measure the rheological properties of fluid/fluid interfaces, which can dramatically affect the flow properties and dynamics of multiphase materials (emulsions, foams, cells and organs). Such measurements can be particularly challenging, as one needs to measure the influence of molecularly thin, two-dimensional layers but be insensitive to the three-dimensional bulk fluids on either side. However, dimensionality helps here: interfacial forces on a probe are exerted along a contact perimeter, whereas the bulk forces are exerted on the contact area. Smaller probes thus increase the perimeter/area ratio, and therefore the relative sensitivity to interfacial viscoelasticity. We fabricate micron-scale ferromagnetic amphiphilic disks (with versatile surface chemistry), place them on the interface, use external electromagnets to exert a known torque (stress), and measure the resulting rotational displacement (strain). In addition to its sensitivity, our technique can measure frequency dependent linear/nonlinear viscoelastic properties and yield stresses. Simultaneous visualization of the interface by fluorescence microscopy allows us to correlate local dynamics withe measured rheology. We validate our technique and highlight its capabilities with measurements on a variety of systems, including two-dimensional colloidal monolayers, fatty acid and phospholipid monolayers.

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Date submitted: 07 Aug 2009 Electronic form version 1.4