33b Rheology and Non-Newtonian Fluid Mechanics of Complex Interfaces

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Complex, fluid interfaces are formed when molecular amphiphiles or particles collect to form structured surfaces that endow them with highly nonlinear and non-Newtonian responses to flow. This paper presents measurement techniques for the determination of surface viscoelasticity and presents data for two different systems: two-dimensional polymer melts and two-dimensional suspensions.

Two-dimensional polymer melts result with amphiphilic polymer chains are spread onto a fluid/fluid interface. These systems are characterized by frequency dependent, dynamic moduli and lead to dramatic changes in interfacial flows in complex geometries. Data are presented on surface rheology for monolayers of poly(tertbutyl methacrylate) over a wide range of molecular weights. When the pressure-area isotherms of this system are plotted on a "per monomer" basis, the data for all molecular weights collapse onto a single master curve. The data indicate a transition from a fluid interface to a solid interace as the system is compressed. Monte Carlo simulations suggest that the chains pile up on top of each other during compression.

Two-dimensional suspensions can be formed by attaching arrays of colloidal particles onto fluid-fluid interfaces. These additives can effectively stabilize emulsions and produce very viscoelastic monolayers that resist coalescence and Ostwald ripening. Data are presented on droplets coated with particle monolayers that are subjected to volume reduction by draining their contents. During this process, the subsequent decrease in surface area of the drops ultimately causes the particles on the interface to jam and a liquid-to-solid transition ensues. Measurement of the internal pressure of the droplets during the drainage process signals the onset of buckling and wrinkling of the droplet surface.