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Soft interfaces: complex, dynamic, reacting and evolving

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Various surface-active species–ranging from small, amphiphilic molecules to proteins to colloidal particles–adsorb to fluid interfaces, enabling multiphase materials like foams and emulsions, biophysical structures like cell membranes and lung surfactant monolayers, and a host of novel two-dimensional materials more generally. Moreover, many such interfaces exhibit rich structural and dynamical properties, including the two-dimensional (surface) analogs of three-dimensional rheology, including viscoelasticity, shear thickening and thinning, and yield stresses. We have developed active interfacial microrheology techniques that simultaneously track the evolution of the microstructure of these complex interfaces, enabling morphology to be directly related to rheology. We will highlight particularly interesting two-dimensional materials, and will also discuss interfaces that evolve as surfactants adsorb (as occurs, e.g., in petrochemical emulsions, or protein solutions) or as reagents react (e.g. during interfacial polymerization reactions). In addition to probing the heterogeneity and mechanical properties of such evolving interfaces, we have developed techniques to visualize the evolution of bulk concentration fields as such reactions proceed, yielding new capabilities to probe reacting and evolving interfaces.