Marangoni Stresses at Deforming Interfaces

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The interface between two immiscible fluid phases is often characterized by a single property, the interfacial tension. Variation of interfacial tension along an interface leads to tangential stresses that are known as Marangoni stresses. In this talk, I will discuss two problems where Marangoni stresses are generated at a fluid interface due to gradients in temperature or surfactant concentration. In the first part of the talk, thermocapillary flows such as those encountered in liquid-encapsulated crystal growth processes are examined numerically. Encapsulating the melt significantly reduces the intensity of the thermocapillary flow within the melt layer. Based on asymptotic observations, we develop a single-layer model by modifying the stress condition at the free surface. The single-layer model accurately predicts the flow within the melt even at high aspect ratios of the rectangular cavity. In the second part of my talk, I will explore the fundamental issues of how surfactants behave near freshly created interfaces at fast time scales and how they change the deformation and break up of a dispersed fluid phase. I will discuss these issues in the context of a bubble or drop that expands at finite Reynolds numbers into a surfactant solution. A front tracking numerical scheme is used to study the effects of surfactants on the growth, evolution and deformation of a drop. Surfactant effects are simulated using a nonlinear surface equation of state that adequately describes real surfactants. Surfactants that accumulate in the neck region significantly affect the pinch off dynamics of the drop.