259e Surfactant Effects on Highly Nonequilibrium Surfaces: Surfactants and Drop Detachment

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When a viscous drop is injected into a viscous fluid, the drop evolves to form a distended shape that detaches via the rapid formation and pinching of a neck. We study how this process is altered by the presence of surfactant numerically. When surfactant adsorption-desorption is very slow, interfaces dilute significantly during drop expansion, and drops form necks which are only slightly perturbed in their dynamics from the surfactant-free case. When adsorption-desorption dynamics are comparable to the rate of expansion, drops break at the primary neck at low surfactant coverage, at a secondary neck at moderate coverages, or fail to neck at elevated coverages. When surfactant adsorption-desorption kinetics are rapid, the surface remains in equilibrium with the surrounding solution, and drops break like surfactant-free drops with a uniform surface tension. These arguments are used to construct a phase diagram of drop break-up modes as a function of surfactant sorption dynamics.