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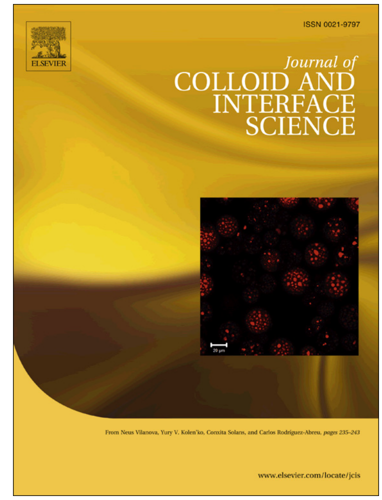

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The Suppression of Droplet-Droplet Coalescence in a Sheared Yield Stress Fluid

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Abstract

Efforts to stabilize emulsions against coalescence in flow have often focused on modifying properties of the interface between the continuous and dispersed phases, and creating a repulsive barrier against coalescence. But prior to experiencing any interaction force, the liquid film between two colliding drops has to drain, and if this drainage process is arrested, coalescence will be suppressed. In this work, scaling analyses and thin-film lubrication simulations are used to study the hydrodynamic drainage properties of thin films of a Bingham fluid (a yield stress fluid, which flows only when a critical stress is exceeded) created between two drops colliding under the action of a constant force. Our study shows that the hydrodynamic drainage process can be arrested completely when the film reaches a critical thickness, *before* attractive forces result in the rupture of the film, provided that the film shape is in the dimpled configuration. This critical thickness is $h_f = 6\tau_0^2 R^3/\gamma^2$, where τ_0 is the yield stress of the suspending medium, R is the drop radius and γ is the interfacial tension between the fluids. The yield stress can thus serve as an independent tuning parameter that sets an upper bound on the drop size beyond which coalescence is turned off in sheared emulsions.