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Interfacial Effects on Droplet Dynamics in Poiseuille Flow STEVEN HUDSON, NIST, JONATHAN SCHWALBE, MITRE, KENDRA ERK, FREDERICK PHELAN JR., NIST, PETIA VLAHOVSKA, Brown University — Many properties of emulsions arise from interfacial rheology. Here we advance theoretical understanding and experimental observation of the dynamics of isolated drops suspended in Poiseuille flow. Stokes flow is assumed in the bulk phases, and a jump in hydrodynamic stress at the interface is balanced by Marangoni forces (linearized with respect to local deviations of interfacial surfactant concentration) and surface viscous forces according to the Boussinesq–Scriven constitutive law. Interfacial diffusion is also included. Our analysis predicts slip, cross-stream migration and droplet-circulation velocities. These results and the corresponding interfacial parameters are separable, enabling a new droplet-based interfacial rheology method to determine interfacial viscosities and Marangoni elasticity. We illustrate such measurements by particle tracking velocimetry of surfactant-stabilized droplets in the Poiseuille flow of a microfluidic device. Small molecule and block copolymer surfactants are examined. This droplet-based interfacial rheology method is attractive since it mimics the natural geometry and length scale of practical emulsions and suspensions.

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