27.1 Non-Newtonian Fluids - Rheology
33.8 Suspensions: Theory and Modeling

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Structural and rheological relaxation upon flow cessation in colloidal dispersions: Transient, nonlinear microrheology RITESH P. MOHANTY, Cornell University, ROSEANNA N. ZIA, Stanford University — We theoretically study the impact of particle roughness, Brownian motion, and hydrodynamic interactions on the relaxation of colloidal dispersions by examining the structural and rheological relaxation after microrheological flow cessation. In particular, we focus on the disparity in timescales over which hydrodynamic and entropic forces act and influence colloidal relaxation. To do this, we employ the active microrheology framework, in which a colloidal probe, driven by an arbitrarily strong external force, interacts with many surrounding particle configurations before reaching steady-state motion. We utilize the steady-state structure around the probe as the initial condition in a Smoluchowski equation that we solve to obtain the structural evolution upon flow cessation. We systematically tune the strength of hydrodynamic and entropic forces, and study their influence on structural and rheological relaxation. Upon cessation, the non-Newtonian behavior arising directly from hydrodynamic forces dissipates instantaneously, while the entropic contributions decay over longer times. We find that increasing pre-cessation external flow strength enhances the relaxation rate, while hydrodynamic interactions slow down the relaxation.

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