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Transient yield in reversible colloidal gels: a micro-mechanical perspective LILIAN JOHNSON, Cornell University, BENJAMIN LANDRUM, WILLIAM RUSSEL, Princeton University, ROSEANNA ZIA, Cornell University — We study the nonlinear response rheology of colloidal gels via large-scale dynamic simulation, with a view toward understanding the micro-mechanical origins of the transition from solid-like to liquid-like behavior during flow startup, and post-cessation relaxation. Such materials often exhibit an overshoot in the stress response during startup, but the underlying microstructural origin of this behavior remains unclear. The gels studied here comprise Brownian particles interacting via hard-sphere repulsion and short-range attraction of strength of $O(kT)$ that leads to formation of a bi-continuous network. The relatively weak bonds allow the network to restructure over time; our recent work defines the structural evolution and dynamics of such coarsening, and its impact on linear-response rheology. Here we investigate the role of particle attractions and evolving structure on the nonlinear response of the gel. Upon startup of an imposed strain rate, the transition from rest to steady flow is characterized by one or more "overshoots" in the shear stress. Experimental studies, in which the overshoots depend on gel age, strain rate, volume fraction, and attraction strength, suggest that the underlying microstructural origin is a two-step process of cage breaking and bond breaking. However, our detailed studies of the microstructural evolution during startup challenge this view. We present a new model of stress development, relaxation, and memory in reversible colloidal gels in which the ongoing age-coarsening process plays a qualitatively new role.

Lilian Johnson
Cornell University

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