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Transient, nonlinear rheology of reversible colloidal gels by dynamic simulation BENJAMIN LANDRUM, WILLIAM RUSSEL, Princeton University, ROSEANNA ZIA, Cornell University — We study the nonlinear rheology of reversible colloidal gels via dynamic simulation as they undergo age- and flow-induced structural evolution, with a view toward understanding and predicting transient behaviors such as multi-step and delayed yield. The gel is formed from 750,000 Brownian spheres interacting via hard-sphere repulsion and O(kT) short-range attraction, where thermal fluctuations are strong enough to allow continued structural rearrangement in the absence of flow. During startup of imposed strain rate, the transition to steady state is characterized by one or more "overshoots" in the stress which suggest initial yield, formation of a stronger gel, and subsequent yield of the new gel. When subjected to step-shear stress, the microstructure undergoes limited creep, followed by viscous flow. This macroscopic "delayed flow" is consistent with previously proposed models of competition between breakage and formation of particle bonds among static load-bearing structures. Our findings suggest, however, that the load-bearing structures evolve, and that the gel's resistance to delayed failure depends upon this structural evolution and reinforcement. We put forth a micro-mechanical model of stress gradient-driven particle transport that captures this macroscopic behavior.

Roseanna Zia
Cornell University

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