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Flow of colloidal suspensions and gels[1]

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Our recent studies of yield of colloidal gels under shear show that yield in such gels occurs in distinct stages. Under fixed stress, yield follows a finite delay period of slow solid-like creep. Post yield, the gel fluidizes and may undergo long-time viscous flow or, in some cases, may re-solidify. Under imposed strain rate, the transition from equilibrium to long-time flow is characterized by one or more stress overshoots, signifying a yield process here as well. These rheological changes are accompanied by evolution in morphology and dynamics of the gel network. Similar regimes have been observed in gels subjected to gravitational forcing; the gel initially supports its own weight, or perhaps undergoes slow, weak compaction. This may be followed by a sudden transition to rapid compaction or sedimentation. Various models have been put forth to explain these behaviors based on structural evolution, but this detail is difficult to observe in experiment. Here we examine the detailed microstructural evolution and rheology of reversible colloidal gels as they deform under gravity, identifying the critical buoyant force at which yield occurs, the role played by ongoing gel coarsening, and similarities and differences compared to yield under shear.

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