

Structural and dynamical heterogeneities in colloidal gel rheology

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Colloidal gels are known to exhibit complex structural and dynamical changes when sheared, particularly when the applied flow is strong enough to cause rupture. Such systems of colloids interacting through short range attractive forces are good models of associating species, such as associating polymers. Here, we investigate the effect of structural rigidity and dynamical heterogeneity on the nonlinear elasticity of colloidal gels that have undergone yielding. These gels are comprised of fluorescent, sterically stabilized poly(methyl methacrylate) colloids that are suspended at intermediate volume fractions in refractive index and density matched solvents. Non-adsorbing polystyrene is added to induce gelation with weak, short-ranged attraction. Our work shows that the nonlinear elasticity in sheared gels can be attributed to the stress-bearing capability imparted by rigid, slow-diffusing clusters that persist after the flow ceases. In addition, we observe a decrease in the subdiffusive motion of the particles as the applied strain increases. This deformation introduces a bimodal distribution in the van Hove self-correlation function, suggesting the existence of a fast and slow subpopulation of colloids within sheared gels. We show that the predictive power of microscopic theories that connect elasticity to localization length can be improved by considering only this slow subpopulation.

