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Reversible and irreversible deformation in hard-sphere colloidal glasses KATHARINE JENSEN, Harvard University, NOBUTOMO NAKAMURA, Osaka University, Harvard University, DAVID WEITZ, FRANS SPAEPEN, Harvard University — Colloidal glass provides a unique experimental system with which to study the structure, defects, and dynamics of amorphous materials. We report experiments on 1.55-μm-diameter, hard-sphere silica colloidal glasses under conditions of uniform shear. We deform the samples to maximum strains ranging from 0.5% to 10% at various strain rates, and then reverse the deformation so that the net bulk strain is zero at the end of the experiment. We use confocal microscopy to follow the 3D, real-time trajectories of roughly 50,000 particles over the course of an experiment. In this way, we probe the elastic, anelastic, and plastic response of the system, with particular emphasis on the specific, local mechanisms of deformation. We directly observe yield as the onset of local, irreversible deformation. In both sheared and unsheared (quiescent) samples, we observe thermally-activated clusters of particles that behave as Eshelby inclusions, undergoing highly localized plastic strain that couples elastically to the surrounding material. We identify and characterize these regions as they develop in the glass, with particular focus on density-related properties including the Voronoi volume and free volume.

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