Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Robust Scaling of Strength and Elastic Constants and Universal Cooperativity in Disordered Colloidal Micropillars DANIEL GIANOLA, DANIEL STRICKLAND, YUN-RU HUANG, Univ of Pennsylvania, PETER DERLET, Paul Scherrer Institute, DAEYEON LEE, Univ of Pennsylvania — We study the uniaxial compressive behavior of disordered colloidal free-standing micropillars composed of a mixture of 3 and 6 μm polystyrene particles. Mechanical annealing enables variation of the packing fraction across the phase space of colloidal glasses. The measured strengths and elastic moduli of the micropillars span almost three orders-of-magnitude despite similar plastic morphology governed by shear banding. We measure a robust correlation between strengths and elastic constants that is invariant to humidity, implying a critical strain of $\sim$0.01 that is strikingly similar to that observed in metallic glasses and suggestive of a universal mode of cooperative plastic deformation. We estimate the characteristic strain of the underlying cooperative plastic event by considering the energy necessary to create an Eshelby-like ellipsoidal inclusion in an elastic matrix. We find that the characteristic strain is similar to that found in experiments and simulations of other disordered solids with distinct bonding and particle sizes, suggesting a universal criterion for the elastic to plastic transition in glassy materials with the capacity for finite plastic flow. In addition, we measure the statistics of load-drops for specimens at three packing fractions. At higher packing fractions, the load-drops scale as a power-law with an exponent close to mean field theory (MFT) predictions. However, the scaling at the lowest packing fraction deviates from MFT.

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Date submitted: 14 Nov 2014 Electronic form version 1.4