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Machine learning characterization for strain localization of granular particles floating at an air-oil interface under tensile deformation[1]

HONGYI XIAO, ROBERT IVANCIC, GE ZHANG, ROBERT RIGGLEMAN, ANDREA LIU, DOUGLAS DURIAN, University of Pennsylvania — Understanding the interplay between plastic deformation and local structural change is important for disordered systems. In this study, quasi-static tensile experiments were performed using a monolayer of polydisperse granular spheres floating at an air-oil interface that induces capillary attractions between particles. Under tensile deformation, the strain in the monolayer localizes into an inclined shear band, upon which failure occurs, and the ductility of the monolayer can be tuned by controlling the capillary interactions via the particle size. Local plastic rearrangements and the corresponding structural changes were extracted from early stage deformation. Using machine learning methods, we developed a scalar field, softness, which indicates the likelihood of a certain structure to rearrange. During a rearrangement, the local softness tends to revert back to the mean system softness, while the near field softness tends to increase, possibly leading to more nearby rearrangements. The yield strain and the strain field near the rearrangements were also examined, and these structure-dynamic relations can be potentially used to inform an elasto-plastic model that incorporates the influence of the local disordered structure.

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