MAR16-2015-008112

Abstract for an Invited Paper
for the MAR16 Meeting of
the American Physical Society

Linking Microstructural Changes to Bulk Behavior in Shear Disordered Matter[1]

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Soft and biological materials often exhibit disordered and heterogeneous microstructure. In most cases, the transmission and distribution of stresses through these complex materials reflects their inherent heterogeneity. Through the combination of rheology and 4D imaging we can directly alter and quantify the connection between microstructure and local stresses. We subject soft and biological materials to precise shear deformations while measuring real space information about the distribution and redistribution of the applied stress.

In this talk, I will focus on the flow behavior of two distinct but related disordered materials; a flowing compressed emulsion above its yield stress and a strained collagen network. In the emulsion system, I will present experimental and computational results on the dynamical response, at the level of individual droplets, that directly links the particle motion and deformation to the rheology. I will also present results that utilize boundary stress microscopy to quantify the spatial distribution of surface stresses that arise from sheared in-vitro collagen networks. I will outline our main conclusions which is that the strain stiffening behavior observed in collagen networks can be parameterized by a single characteristic strain and associated stress. This characteristic rheological signature seems to describe both the strain stiffening regime and network yielding.

[1]NSF DMR: 0847490