MAR14-2013-020275

Abstract for an Invited Paper
for the MAR14 Meeting of
the American Physical Society

Strain stiffening and stress heterogeneities in sheared collagen networks[1]

JEFFREY URBACH[2], Georgetown University

Disordered networks of stiff or semi-flexible filaments display unusual mechanical properties, including dramatic stiffening when sheared, but little is known about the spatial distribution of stresses. This talk will introduce the technique of *Boundary Stress Microscopy*, which adapts the approach of traction force microscopy to rheological measurements in order to quantify the non-uniform surface stresses in sheared soft materials. Our results on networks of the biopolymer collagen, a major component of the extracellular matrix, show stress variations over length scales much larger than the network mesh size. We find that the heterogeneity increases with strain stiffening, with stresses at high strains exceeding average stresses by an order of magnitude. The strain stiffening behavior over a wide range of mesh sizes can be parameterized by a single characteristic strain and associated stress, which describes both the strain stiffening regime and network yielding. The characteristic stress is approximately proportional to network density, but the peak stress at both the characteristic strain and at yielding are remarkably insensitive to concentration. These results show the power of Boundary Stress Microscopy to reveal the nature of stress propagation in disordered soft materials, which is critical for understanding many important mechanical properties, including the ultimate strength of a material and the nature of appropriate microscopic constitutive equations.

[1]Supported by the AFOSR (FA9550-10-1-0473) and the NSF (DMR-0804782).

[2]In Collaboration with R.C. Arevalo, P. Kumar, and D. L. Blair