



FRONTIERS IN MICRORHEOLOGY



A test of stress-based statistics for granular assemblies using soft glassy rheology

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Abstract: The Soft Glassy Rheology model [P. Sollich, Phys. Rev. E 58, 738 (1998)] has been used extensively to analyze the rheological behavior of athermal, disordered, soft materials that can flow in response to macroscopic strains. The long-time dynamics are determined by escape from potential-energy traps via some activated process. In analogy to thermal systems, the fluctuations enabling the activated process are controlled by a noise temperature, and the distribution of trap energies is taken to be . Recently, a statistical framework based on stress rather than energy has been proposed for materials such as granular assemblies that do not conserve energy [SH, C. S. O’Hern, and BC, Phys. Rev. Lett. 99, 038002 (2007)]. The new framework identifies a non-thermodynamic “temperature”, α that controls the fluctuations. The present work incorporates these new ideas into the SGR model, namely, we consider an activated trap-hopping process controlled by the effective temperature α and the trap depth is proportional to the stress. The result shows that in the high strain-rate ($\dot{\gamma}$) regime, the shear stress is proportional to $\ln(\dot{\gamma})$. This result is distinguishable from the SGR prediction of $\sigma \sim \ln(\dot{\gamma})$ and provides a test for the new statistical ensemble. We will show that results from the stress-based ensemble are in agreement with experiments on sheared granular matter in a couette [R. R. Hartley and R. P. Behringer, Nature 421, 928 (2003).].



The Frontiers in Microrheology Workshop
February 6 - February 9, 2008
at the CNSI, UCLA

<http://www.cnsi.ucla.edu/conferences/microrheology/>

