Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Imaging the microscopic structure of shear thinning and thickening colloidal suspensions XIANG CHENG, Cornell University, JONATHAN MCCOY, Colby College, JACOB ISRAELACHVILI, University of California Santa Barbara , ITAI COHEN, Cornell University — The viscosity of colloidal suspensions can vary by orders of magnitude depending on how quickly they are sheared. Although this non-Newtonian behavior is believed to arise from the arrangement of suspended particles and their mutual interactions, microscopic particle dynamics in such suspensions are difficult to measure directly. Here, by combining fast confocal microscopy with simultaneous force measurements, we systematically investigate a suspension's structure as it transitions through regimes of different flow signatures. Our measurements of the microscopic single-particle dynamics unambiguously show that shear thinning results from the decreased relative contribution of entropic forces and that shear thickening arises from particle clustering induced by inter-particle hydrodynamic lubrication forces. Furthermore, we explore out-of-equilibrium structures of sheared colloidal suspensions and report a novel string phase, where particles link into log-rolling strings normal to the plane of shear. Our techniques illustrate an approach that complements current methods for determining the microscopic origins of non-Newtonian flow behavior in complex fluids.

Xiang Cheng
Cornell University

Date submitted: 09 Nov 2011 Electronic form version 1.4