Abstract Submitted
for the DFD07 Meeting of
The American Physical Society

Nano-Rheology: Stress Shielding and Stick-Slip Dynamics XINGUANG CHENG, HSUEH-CHIA CHANG, Department of Chemical and Biomolecular Engineering, University of Notre Dame — A molecular Langevin theory explains the rich and nonlinear viscoelastic rheology exhibited by monolayers and bilayers of water confined between two charged mica surfaces. Elastic storage endowed by asymmetric water-surface and water-water interaction is shown to produce a curious stress shielding phenomenon. Noise-sensitive stick-slip dynamics occurs when the surface speed is comparable to the molecular equilibration speed, with distinct hopping statistics between surface sites captured by a Fokker-Planck analysis. At large displacement, two-time asymptotics shows that sliding dynamics over multiple sites is responsible for the viscous properties but the elastic component is due to slow near-equilibrium dynamics at the slow intervals. Scaling theories for the rheological moduli are favorably compared to literature data. Both stress shielding and slip at large amplitudes are responsible for the 1e4-1e5 order difference in reported viscosity.

Xinguang Cheng
Department of Chemical and Biomolecular Engineering,
University of Notre Dame

Date submitted: 04 Aug 2007 Electronic form version 1.4