Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Modeling and measuring non-Newtonian shear flows of soft interfaces.[1] JUAN LOPEZ, Arizona State University, ADITYA RAGHUNANDAN, PATRICK UNDERHILL, AMIR HIRSA, Rensselaer Polytechnic Institute — Soft interfaces of polymers, particles, and proteins between fluid phases are ubiquitous in industrial and natural processes. The flow response of such systems to deformation is often not linear, as one would expect for Newtonian interfaces. The resistance to (pure shear) flow of interfaces is generally characterized by a single intrinsic material property, the surface shear viscosity. Predicted shear responses of Newtonian interfaces have achieved consensus across a wide range of flow conditions and measurement devices, when the nonlinear hydrodynamic coupling to the bulk phase is correctly accounted for. However, predicting the flows of sheared non-Newtonian interfaces remains a challenge.

Here, we introduce a computational model that incorporates a non-Newtonian constitutive equation for the sheared interface and properly accounts for the coupled interfacial and bulk phase flows. We compare predictions to experiments performed with a model phospholipid system, DPPC - the main constituent of mammalian lung surfactant. Densely packed films of DPPC are directly sheared in a knife-edge surface viscometer. Yield-stress and shear thinning behaviors are shown to be accurately captured across hydrodynamic regimes straddling the Stokes flow limit to inertia dominated flows.

[1]Supported by NASA grant NNX13AQ22G

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Date submitted: 01 Aug 2017 Electronic form version 1.4