Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Asymmetric bubble collapse and jetting in generalized Newtonian fluids RATNESH K. SHUKLA, Indian Institute of Science, JONATHAN B. FREUND, University of Illinois at Urbana-Champaign — The jetting dynamics of a gas bubble near a rigid wall in a non-Newtonian fluid are investigated using an axisymmetric simulation model. The bubble gas is assumed to be homogeneous, with density and pressure related through a polytropic equation of state. An Eulerian numerical description, based on a sharp interface capturing method for the shear-free bubble-liquid interface and an incompressible Navier-Stokes flow solver for generalized fluids, is developed specifically for this problem. Detailed simulations for a range of rheological parameters in the Carreau model show both the stabilizing and destabilizing non-Newtonian effects on the jet formation and impact. In general, for fixed driving pressure ratio, stand-off distance and reference zero-shear-rate viscosity, shear-thinning and shear-thickening promote and suppress jet formation and impact, respectively. For a sufficiently large high-shear-rate limit viscosity, the jet impact is completely suppressed. Thresholds are also determined for the Carreau power-index and material time constant. The dependence of these threshold rheological parameters on the non-dimensional driving pressure ratio and wall stand-off distance is similarly established. Implications for tissue injury in therapeutic ultrasound will be discussed.

Jonathan B. Freund
University of Illinois at Urbana-Champaign

Date submitted: 25 Jul 2017 Electronic form version 1.4