Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Near-wall bubble expansion and jetting collapse in generalized Newtonian fluids JONATHAN FREUND, University of Illinois at Urbana-Champaign, RATNESH SHUKLA, Indian Institute of Science — The jetting dynamics of a gas bubble near a wall in a non-Newtonian fluid are investigated using axisymmetric simulations. The bubble gas is assumed homogeneous, with density and pressure related through a polytropic equation of state. An incompressible, Eulerian-frame, Navier-Stokes solver for generalized Newtonian fluids is used, with discretization modified to sharply represent the shear-free bubble-liquid interface. Simulations show both stabilization and destabilization due to non-Newtonian effects. In general, for fixed zero- and infinite-shear-rate viscosities, shear-thinning promotes and shear-thickening suppresses jet formation and impact. For a shear-thinning fluid, a threshold Carreau time scale λ is found that suppresses both jetting and impact. Likewise, for shear-thickening, a minimum is found that suppresses both. The bubble-wall speed increases sharply with shear thinning and decreases for shear thickening. However, the bubble volume is far less sensitive, changing less than 50% for $0 < \lambda < \infty$. The general trends, and particularly the high sensitivity of the jet speed to λ, suggest a criterion that could potentially protect tissue in biomedical application and be used for high-strain-rate, large-deformation rheology.

Jonathan Freund
University of Illinois at Urbana-Champaign

Date submitted: 01 Aug 2019 Electronic form version 1.4