Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Dynamics of highly deformed non-spherical vesicles in steady and time-dependent flow[1] DINESH KUMAR, CHANNING M. RICHTER, CHARLES M. SCHROEDER, Department of Chemical and Biomolecular Engineering, University of Illinois at Urbana-Champaign — In this work, we study the non-equilibrium dynamics of vesicles in precisely-defined steady and time-dependent extensional flow. Using Stokes trap, we directly observe non-equilibrium vesicle shapes as a function of reduced volume ν, viscosity contrast λ, and Capillary number Ca using fluorescence microscopy. Vesicles are found to deform through a wide-range of interesting shapes in flow, including asymmetric and symmetric dumbbells, in addition to pearling, wrinkling, and buckling instabilities depending on membrane properties. Using this approach, we determine the flow phase diagram for vesicles in ν-Ca space. Our results show that the steady-state deformation of vesicles exhibits power-law behavior as a function of reduced Capillary number. We identify two distinct relaxation processes for vesicles stretched to high deformation, revealing two characteristic time scales: a short time scale corresponding to bending relaxation and a long-time scale dictated by the relaxation of membrane tension. We further discuss the dynamics of single vesicles in sinusoidal oscillatory extensional flow as a function of Ca and Deborah number.

[1]This work was supported by the National Science Foundation by Award # NSF CBET 1704668.

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Date submitted: 01 Aug 2019 Electronic form version 1.4