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The interplay of fluid inertia and fluid viscoelasticity in complex microfluidic flows LUCY RODD, Hatsopoulos Microfluids Lab, MIT and Dept. of Chemical Engineering, Univ. Melbourne, DAVID BOGER, Department of Chemical and Biomolecular Engineering, University of Melbourne, Victoria, Australia, JUSTIN COOPER-WHITE, Division of Chemical Engineering, University of Queensland, Brisbane, Australia, GARETH MCKINLEY, Hatsopoulos Microfluids Laboratory, MIT, Cambridge MA 02139, USA — The interplay of inertia and elasticity is explored by investigating the extensional flow behavior of dilute solutions of high molecular weight polyethylene oxide (PEO) flowing through micro-fabricated contractions. The small length scales and high deformation rates inherent to microfluidic devices make it possible to induce strong non-Newtonian effects even in dilute polymer solutions. By preparing solutions with varying solvent viscosities, it is possible to tune the ratio of elasticity to inertia at the same polymer concentration. The kinematics upstream of the contraction are characterized in terms of the strong viscoelastic enhancement of the corner vortex, which is accompanied by an increase in the pressure drop across the contraction plane that reaches a value in excess of 6 times the equivalent Newtonian pressure drop. The shape and maximum of the pressure drop/flowrate curve is found to be strongly dependent on the elasticity number, which is only a function of fluid properties and the size of the channel. This work provides valuable insight into the behavior of macromolecular fluids that are common in lab-on-a-chip processes, such as those containing proteins or dilute solutions of DNA.

Gareth Mckinley
Hatsopoulos Microfluids Lab, Dept. Mechanical Engineering
MIT, Cambridge, MA 02139

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