Abatement of mixing in shear-free elongationally unstable viscoelastic microflows

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Abstract

The addition of minute amounts of chemically inert polyacrylamide polymer to liquids results in large instabilities under steady electro-osmotic pumping through 2:1 constrictions, demonstrating that laminar flow conditions can be broken in electro-osmotic flow of viscoelastic material. By excluding shear and imposing symmetry we create a platform where *only* elongational viscoelastic instabilities, and diffusion, affect mixing. In contrast to earlier studies with significant shear that found up to orders of magnitude increase in mixing we find that inclusion of polymers excites large viscoelastic instabilities yet mixing is *reduced* relative to polymer-free liquids. The absolute decrease in mixing we find is consistent with the understanding that adding polymer increases viscosity while viscoelastic flows progress towards elastic turbulence, a type of mild (Batchelor) turbulence, and indicates that electro-osmotic pumped devices are an ideal platform for studying viscoelastic instabilities without supplementary factors.

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