Dynamics of a viscoelastic liquid subjected to an AC electric field

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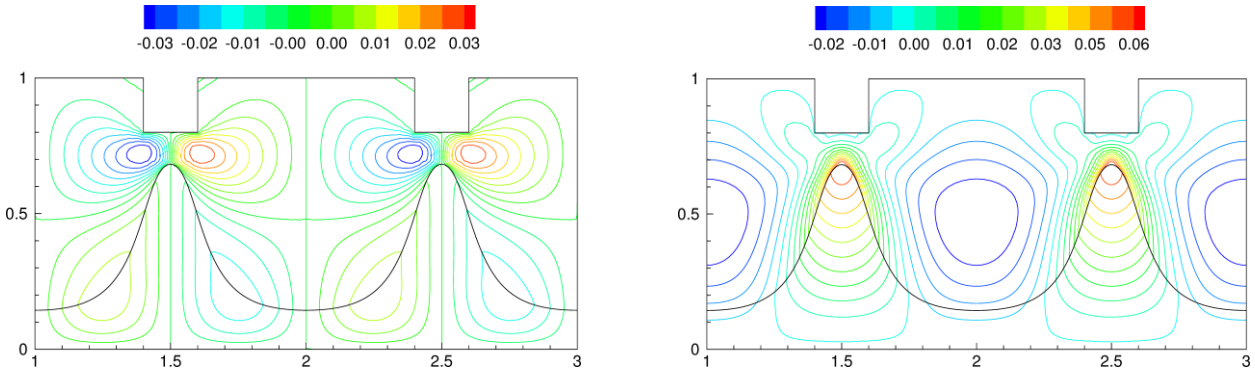
We investigate the non-linear dynamics of the electro-hydrodynamic instability of a polymer film which is separated from the top electrode by a viscous fluid under the influence of an AC electric field. Our main goal is to investigate the interaction of elasticity with the amplitude and frequency of oscillation of an AC field and how it could modify electrohydrodynamic instabilities in thin polymer films. We develop a computational model and carry out 2D numerical simulations fully accounting for the flow and electric field in all phases. For the numerical solution of the governing equations we employ the mixed finite element method combined with a quasi-elliptic mesh generation scheme which is capable of following the large deformations of the liquid-liquid interface. We model the viscoelastic behavior using the Phan-Thien and Tanner (PTT) constitutive equation taking fully into account the non-linear elastic effects as well as a varying shear and extensional viscosity. We perform a thorough parametric study and investigate the influence of the electric properties of fluids, applied frequency and amplitude of the AC voltage and various rheological characteristics of the polymeric liquid.



(a) (b)

Figure: Flow field of a viscoelastic bilayer subjected to an electric field. Contour lines of velocity component in (a) x-direction and (b) y-direction.

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