A numerical study of electrohydrodynamic patterning of viscoelastic materials

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Abstract

A computational model is developed to study the manufacturing of fine structures using the electrohydrodynamic patterning processes. We consider the flow of a viscoelastic material under the influence of an applied electric field and investigate the non-linear dynamics by carrying out 2D numerical simulations, fully accounting for the flow in both phases. The viscoelastic behavior is modelled using the affine Phan-Thien and Tanner (PTT) constitutive equation [1]. For the numerical solution of the governing equations the mixed finite element method is combined with a quasi-elliptic mesh generation scheme in order to capture the large deformations of the liquid-air interface. We perform a thorough parametric study and investigate the influence of the various rheological parameters, the applied voltage and geometrical characteristics of the mask in order to define the fabrication limits of this process in the case of periodic structures.

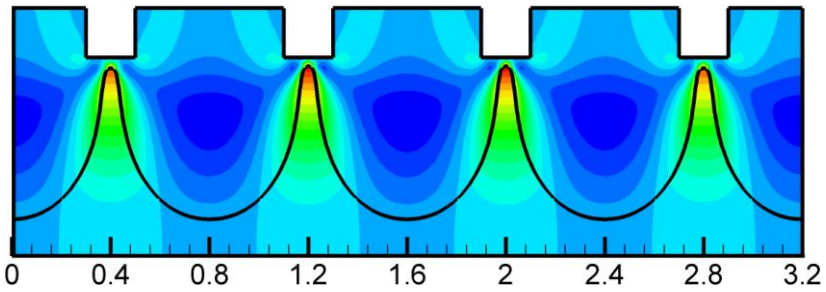

FIG. 1. Contour plots of the vertical velocity component. The black line shows the polymer-air interface as predicted by the non-linear numerical model.

[1] N. Phan-Thien, A nonlinear network viscoelastic model, J. Rheol., 22, 259–283 (1978).

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