Viscoelastic drop deformation in 5:1:5 contraction/expansion micro-channel flow

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We developed a numerical algorithm to investigate the drop deformation in a 5:1:5 contraction/expansion micro-channel. Only two-dimensional deformation was considered since the depth of the drop is controlled by the channel depth in the non-spherical material fabrication. Viscosity and relaxation time of viscoelatic fluid were set differently between drop and matrix, whereas density was assumed to be same. Oldroyd-B model was adopted as a constitutive equation for viscoelastic drop. As stabilizing schemes for elastic instability, discrete elastic viscous stress splitting (DEVSS-G), streamline upwind Petrov Galerkin (SUPG) and matrix logarithm techniques were applied to the governing equations including momentum equation and continuity equation with finite element formulation. Front tracking method was used to track the interface of the drop. Immersed boundary method was implemented to deal with surface tension.

In the case of Newtonian drop in Newtonian matrix, the effect of surface tension on the viscous drop was studied. In the case of viscoelastic drop in Newtonian matrix, as the relaxation time increases, a distinct drop behavior was observed at both expansion and contraction channel.