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NUMERICAL STUDY OF MULTIPHASE FLOWS OF VISCOELASTIC FLUIDS IN A SUDDEN CONTRACTION-EXPANSION

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This work presents a numerical investigation of multiphase flows of rheologically complex fluids in microfluidic devices. In particular, we investigate the viscoelastic instabilities on the liquid-droplet flow of dissimilar viscoelastic Boger fluids [1] in an abrupt contraction/expansion micro-channel. By changing the properties of both the liquid droplet and carriage fluid (the ratio of the viscosities and relaxation times), different flow configurations were simulated with an emphasis at exploring flow instabilities triggered by viscoelasticity.

We use the Level-Set method [2] to compute the liquid-liquid flows, which has been implemented in a in-house viscoelastic flow solver. In the Level-Set method, the interface is represented by a closed curve using the so-called level-set function. This function is governed by a Hamilton-Jacobi partial differential equation particularly suitable for the simulation of changing topologies, which is solved numerically.

The code is verified by solving the droplet transport problem for a Newtonian fluid. After this verification, we employ the Oldroyd-B model to describe the rheology of different Boger fluids, and assess the behaviour of the droplet transport in the constriction micro-geometry. Finally, a detailed study of the viscoelastic instabilities on the relevant rheological parameters of the non-linear viscoelastic models is reported, regarding the effect of both the relaxation time and fluid polimer viscosities ratio of both the droplet and carriage fluid.

References:

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