144l Elastic and Surfactant Effects on Dynamics of Drops Translating in a Microfluidic Device

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Tremendous progress has been made in the development of microfluidic devices in the last decade with applications such as a "lab-on-a-chip", ink-jet printer heads, microdroplets as actuators, chemical microreactors, and drug delivery vehicles. Several applications of two-phase systems in microdevices involve viscoelastic fluids in the presence of surfactants often added as stabilizers. In this study we present the results of our experimental study on the motion of drops translating in a microfluidic device in the presence of elastic and / or surfactant effects. Microfluidic devices of varying cross-sections and sizes are fabricated using standard soft lithography techniques. The bulk phase is silicone oil and the dispersed phase includes various concentrations of carboxymethyl cellulose (CMC), polyethylene oxide (PEO), and polyacrylamide (PAM) solutions. The stretching of polymer chains present in viscoelastic fluids causes large normal stresses to develop at deforming interfaces affecting the dynamics of drops. Surfactant molecules adsorbed at the interface lead to a local reduction in surface tension resulting in highly curved interfaces and reduced tangential velocities due to the induced Marangoni stresses. The effects of elastic stresses and mass transfer kinetics on the shape and terminal velocity of a drop translating in a microchannel are presented. The effect of the shape of the confining wall is also explored.