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Controlling viscoelastic flow in microchannels with Slip

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Abstract-

We show that viscoelastic flow in a microchannel under a dynamic pressure gradient dramatically changes with the value of the apparent slip. We demonstrate this by using classical hydrodynamics and the Navier boundary condition for the apparent slip. At certain driving frequencies, the flow is orders of magnitude different for systems with and without slip, implying that controlling the degree of hydrophobicity of a microchannel can lead to the control of the magnitude of the flow. We verify this for viscoelastic fluids with very different constitutive equations. Moreover, we demonstrate that flow, given a value of the apparent slip, is a non-monotonic function of the driving frequency and can be increased or reduced by orders of magnitude by slightly changing the frequency of the driving pressure gradient. Finally, we show that, for dynamic situations, slip causes and effectively thicker channel whose effective thickness depends on frequency. We have calculated relevant quantities for blood and a polymeric fluid in order to motivate experimental studies.

Index Terms-

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