

Abstract Submitted
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Modeling fluid–structure interactions in shallow microchannels

TANMAY C. SHIDHORE, IVAN C. CHRISTOV, School of Mechanical Engineering, Purdue University — Rectangular microfluidic conduits with deformable walls are some of the simplest and most extensively studied microfluidic devices, primarily due to their practical design applications in a variety of fields like biology, medical diagnostics (e.g., lab-on-a-chip), nanotechnology, etc. Experimentally, these devices are found to deform into a non-rectangular cross-section due to fluid–structure interactions occurring at the channel walls. These deformations significantly affect the flow profile, which results in a non-linear relationship between the flow rate and the pressure drop, which cannot be explained by a ‘generalised Poiseuille flow solution’. To this end, we perform a numerical study of these fluid–structure interactions and their effect on the flow rate and the pressure drop occurring in microfluidic conduits with a single deformable wall. The behavior of several shallow conduit systems ($\ell \gg w \gg h$) with rigid base and side walls and a soft top wall (e.g., PDMS) is simulated under laminar flow conditions using the commercial software suite ANSYS. Simulation results are compared against experimental pressure drop–flow rate data from the literature and also newly developed analytical expressions for the wall deformation, the pressure and the normalized flow rate.

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