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Inertial instability of viscosity-stratified flows in microchannels[1]
XIAOYI HU, THOMAS CUBAUD, Stony Brook University — The hydrodynamic stability of stratifications made between miscible fluids having large differences in viscosity is experimentally investigated in square microchannels. Parallel fluid layers with a fast central stream and a slow sheath flow are produced by focusing a low-viscosity fluid into a high-viscosity fluid in a straight microchannel. Although such fluid arrangements are typically governed with the flow rate ratio and the viscosity contrast at low Reynolds numbers Re, the formation of periodic wave trains at each fluid interface is observed for moderate Re. Several functional relationships are developed for the propagating velocity, size, and frequency of the generated waves over a range of viscosities and flow rates. In particular, we demonstrate the wave phase locking for small central streams and show the production of high-viscosity fluid ligaments at the wave crests. In this regime, minute amount of high-viscosity fluid is entrained and blended into the low-viscosity fluid recirculating plumes formed by the traveling interfacial waves.

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