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Inertial effects in microfluidic flow focusing and mixing ASHWIN RAMACHANDRAN, Stanford University, WEI LIAO, Tsinghua University, DANIEL P DEPONTE, SLAC National Accelerator Laboratory, JUAN G SANTIAGO, Stanford University — A wide range of microfluidic devices focus a center stream between two symmetric sheath streams on either side. These devices are used to achieve a thin laminar stream with dimensions much smaller than the channel dimension, and to achieve rapid mixing to initiate reactions. We are using flow modeling and experiments to study the effects of flow inertia on such flow focusing. At low Reynolds numbers, these flows have been well studied and produce relatively simple flows with the center (sample) stream focused along the centerline of the output channel. At Reynolds (and Dean) numbers of order 10, we observe complex streamlines in these flows including three dimensional (3D) secondary flows such as 3D vortical structures. In some conditions, the center stream bifurcates into two or four streams which then flow near opposite walls of the outlet channel. We are also studying the effects of unwanted asymmetric imperfections in the inlet flows of these devices. We find inertial effects can determine which side of the outlet channel the output sample stream will flow. These studies have implications in microfluidic system design and estimates of mixing time scales for such flows.

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