Microchannel miter bend effects on pressure equalization and vortex formation

Abstract

Simulations have been carried out for water flow in a square microchannel with a miter bend. The simulation considered a pressure-driven flow in a channel-hydraulic diameter of 5 μm for series of Reynolds number (Re) range from 0.056 to 560, in order to investigate water flow at bends. The result shows formation of two vortices after the miter bend, which are more discernible above Re 5.6. The critical inlet velocity for the generation of vortex in this particular geometry occurs at 1 m/s. A simple energy mechanism is postulated to explain the vortex formation as well as core skew direction. The high pressure region at the outer wall before and after the bend is a major factor for vortex formation since the liquid needs to reduce the additional energy effected by the high pressure region. Navier-Stokes equation is utilized with a no slip boundary condition for a total microchannel centerline length of 795 μm which is sufficient to produce a laminar flow pattern at the outlet.