TEMPERATURE AND VELOCITY MEASUREMENTS IN 90 DEGREE BEND MICROCHANNEL FLOW

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ABSTRACT: This paper examines the temperature and velocity profiles in a 90 degree bend microchannel using molecule-based temperature sensor and micro-particle image velocimetry (micro-PIV) techniques. These techniques are capable of providing both detailed and global profiles for velocity and temperature investigation in microfluidic research. The molecule-based temperature sensor technique used Rhodamine B as the temperature probe to provide non-invasive and straightforward temperature measurements with accuracy around 1 ^{o}C. To further resolve the luminescence deviation/reflection of luminescence based temperature measurements around the bend, pixel-by-pixel correction was applied along with in-situ calibration method. The temperature and velocity measurements were performed in a 200 μm wide, 67 μm deep and 2 cm long PDMS microchannel with 90 degree sharp bend at the center. The temperature profile was measured at a Reynolds number of 27.66 with DI water as working fluid, and the bottom of channel was heated at a constant temperature of 50 ^{o}C. The velocity profile around the 90 degree sharp bend was acquired at the same Reynolds number using micro PIV technique. Secondary flow structure around the corner was observed with multiple layers measurements along the depth of the microchannel. The temperature distributions before and after the corner in axial(x) and crosswise(y) directions show enhanced heat transfer as a result of flow mixing from the secondary flow while passing through the corner. This study not only measured and analyzed the flow and thermal fields in the microchannel but also provided essential information of the flow structure resulting in the heat transfer enhancement.

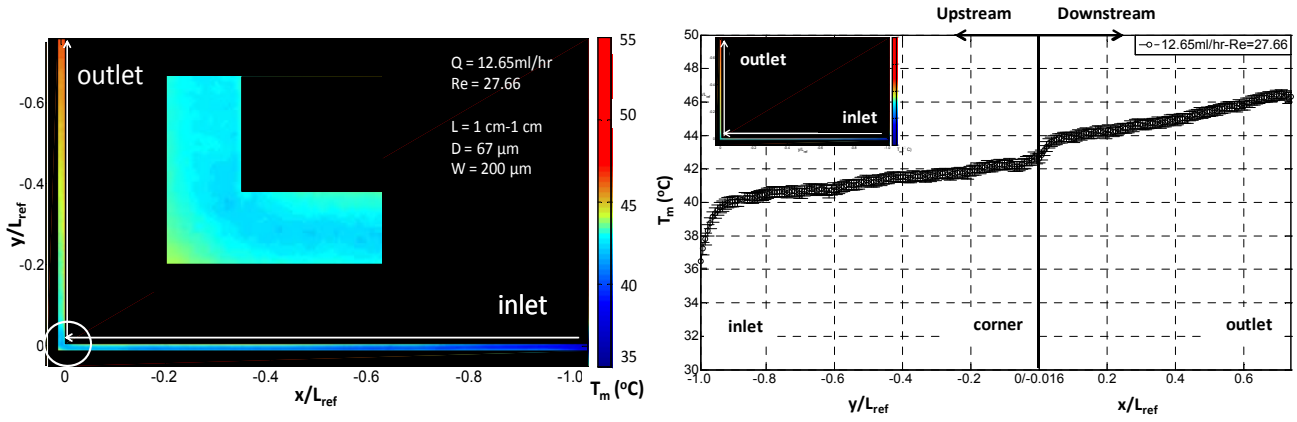

Fig. 1 Temperature contours (left) and temperature variation along the center line (right) in the 90 degree bend microchannel

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