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# Dimensionless analysis on liquid-liquid flow patterns and scaling law on slug hydrodynamics in cross-junction microchannels

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**Abstract**

Liquid-liquid flow patterns and slug hydrodynamics were experimentally studied in non-circular glass microchannels with water-butanol, water-toluene, water-oil and water-hexane systems, considering various hydraulic diameters (600 μm, 400 μm, 200 μm), inlet junctions (crossed, T) and aspect ratios (0.5, 1). The aqueous phase was the continuous phase due to the hydrophilic microchannel walls and the organic phase was the dispersed phase. Three main flow patterns were observed, i.e., annular flow, slug flow and droplet flow. The mechanism of flow pattern formation was explained by a force analysis, based on which, a dimensionless analysis regarding Weber number and Reynolds number was performed to develop general flow pattern transition criteria. Additionally, slug velocities and slug length were investigated. A new scaling law was proposed to predict the slug length and it showed a good agreement with the experimental results. A linear relationship between the slug velocity and the bulk velocity of the two phases was obtained.

Key words: liquid-liquid flow, flow patterns, flow pattern map, slug formation, slug hydrodynamics