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Asymmetric Breakup of a Single Droplet through a Y-Junction Microchannel with Non-Uniform Flow Rate

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Abstract

In this paper, the asymmetric breakup dynamics of an isolated water droplet through a Y-junction microchannel with non-uniform outlet flow rates are numerically investigated under a wide range of capillary number ($0.01 < Ca < 0.3$), outlet flow ratio ($1 < \lambda < 11$), and initial droplet volume ($0.7 < V^* < 4.0$). Four distinct breakup regimes, namely, Obstructed-Obstructed breakup, Obstructed-Tunnel breakup, Tunnel-Tunnel breakup, and Non-breakup, were recognized. The effects of the important parameters on the breakup characteristics are quantitatively determined, and the correlations are fitted to predict the breakup threshold. As per the results, the evolution of neck thickness is significantly influenced by the outlet flow-rate ratio and capillary number but is less dependent on the initial droplet volume. A series of correlations are proposed under various Ca and V^* values to describe the variation in the volume ratio of daughter droplets based on the exponential law.

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