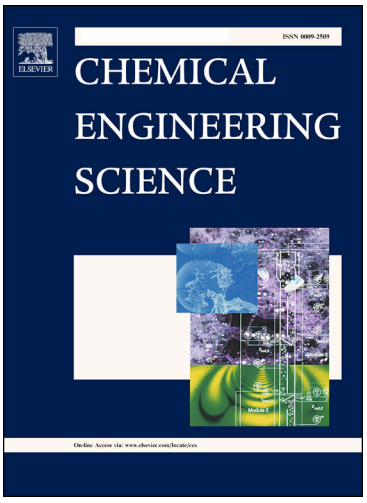

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Three-dimensional simulation of droplet dynamics in planar contraction microchannel

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Abstract

In droplet-based microfluidic systems, microchannel design plays a primary role in transport and manipulation of liquid droplets. The objective of this paper is to investigate dynamics of a droplet in planar contraction microchannel via three-dimensional numerical simulation and theoretical analysis. In particular, this study characterizes three regimes of the droplet dynamics, namely, trap, squeeze and breakup, depending on capillary number (Ca) and contraction ratio (C). In addition, theoretical models have been proposed to describe transitions from one to another regime as a function of Ca and C. For the transition from trap to squeeze, the critical capillary number (Ca_{Ic}) was found to follow $Ca_{Ic} = a(C^M - 1)$, whereas the critical capillary number (Ca_{IIc}) of transition from squeeze to breakup corresponds to $Ca_{IIc} = c_1 C^{-1}$. Furthermore, details of the droplet dynamics along

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