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The Coalescence Process of Droplet Pairs in Different Junctions

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Abstract : Droplet-based microfluidics have been studied extensively with the development of the Micro-Electro-Mechanical System (MEMS) which bears the advantages of high throughput, high efficiency, low cost and low polydispersity. Droplets, worked as versatile carriers, could provide isolated chambers as the internal dispersed phase is protected from the outside continuous phase. Droplets are used to add reagents to start or end bio-chemical reactions, to generate concentration gradients, to realize hydrate crystallization or protein analyses, while droplets coalescence acts as an important control technology. In this paper, deionized water is used as the dispersed phase, and several kinds of oil are used as the continuous phase to investigate the influence of the viscosity ratio of the two phases on the coalescence process. The microchannels are fabricated by coating a polydimethylsiloxane (PDMS) layer onto another PDMS flat plate after corona treatment. All newly made microchannels are rinsed with the continuous oil phase for hours before experiments to ensure the swelling fully developed. High-speed microscope system is used to document the serial videos with a maximum speed of 2000 frames per second. The critical capillary numbers (Ca*) of droplet pairs in various junctions are studied and compared. Ca* varies with different junctions or different liquids within the range of 0.002 to 0.01. However, droplets without extra control would have the problem of synchronism which reduces the coalescence efficiency.

Keywords : coalescence, concentration, critical capillary number, droplet pair, split
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