Hydrodynamic control of droplet behavior for a multiplex static droplet array

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Droplet control is an essential technique in droplet-based microfluidics for a versatile assay platform. Understanding the hydrodynamics of these soft liquid droplets in the microscale channels thus contributes substantially to enhancing the performance of a droplet based micro-total analysis system (μTAS) and high-throughput screening (HTS). Here, we present experimental investigation results in terms of droplet behavior for the stable formation of multiples microfluidic static droplet array (μSDA) system. We evaluate the relationship between droplet dynamics and microfluidic channel design using dimensionless parameters, including capillary number, droplet extension, and the channel resistance ratio. In addition, we find the critical factor between droplet breakup and non-breakup conditions as a function of the capillary number and initial droplet extension. We demonstrate that by using an optimized microfluidic design and optimized flow conditions, an error-free 100 multiplex μSDA is formed through combinatorial coalesce of the droplets via microvalve operation.