Electrohydrodynamic Coalescence of Aqueous Two-Phase Microdroplets

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Controlled coalescence of microdroplet is an important means of performing reactions such as chemical synthesis, kinetics studies, and particle formation in microfluidic devices. We report electrohydrodynamic method of microdroplet coalescence of tetrabutylammonium bromide (TBAB) and ammonium sulfate(AS) aqueous two-phase system. Two microdroplets of AS-rich phase are generated simultaneously in two different microfluidic channels filled with TBAB-rich continuous phase and guided into the main microfluidic channel for coalescence. Although they are not in contact with each other, they are merged into one droplet by d. c. electric pulse applied for less than a second. The coalescence of binary droplets is visually demonstrated by mixing of a dye added in one of the droplets. The conditions for binary droplet coalescence such as distance between the droplets, positional arrangement of the droplets, electric pulse duration and magnitude are analyzed by statistical study. We also discuss the electrohydrodynamic forces related to microdroplet coalescence by analyzing deformation of droplets from the digital snapshots taken at the moment of coalescence.