Title: Numerical investigation on the microfluidic droplet coalescence under the influence of capillary-wettability interaction.

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Abstract

With the growing applications of droplet-based microfluidics, the fundamental understanding of the dynamics of droplet coalescence in several areas, ranging from oil-recovery to lab-on-a-chip, has become more important. The present study numerically investigates the dynamics of droplet coalescence of a liquid-gas immiscible system in a microfluidic rectangular confinement through Volume of Fluid (VOF) approach in OpenFOAM (version 2.3.0). The study illustrates the interplay of some of the crucial physicochemical factors such as wettability and capillary number on the phenomena of droplet coalescence when two droplets are positioned on two opposite surfaces of the microfluidic confinement. Numerical investigation corresponds to various capillary number (*Ca*) viz. 0.35, 0.50.0.66 and 0.81 under several strong hydrophobic surface configurations in terms of contact angles viz. 135°, 140° and 150°. It has been observed that the interplay of wettability and capillary number has direct impact on the temporal evolution of the coalescing droplet which has been portrayed by evaluating morphology of the droplets i.e. droplet shape, droplet area etc. The investigation shows that the increase in capillarity causes more elongation to coalesced droplet and thus, at higher capillary number, dumbbell shaped merged droplet has been observed which confirms the delay in the droplet coalescence process. Besides that, it has been reported that, the alternate contraction and elongation causes fluctuation in the area of merged droplets with expanse of time.