Effect of Interfacial Tension on Droplet Generation in T Junction Microfluidic Device

Ayushman Singh[1]

[1]Indian Institutes of Technology Madras, Chennai, Tamil Nadu, India

Abstract

Droplet generation in microfluidics is a powerful technique to get monodispersed emulsions and droplet size manipulation can be very advantageous in a wide area of applications such as pharmaceuticals, drug delivery, food products, chemical synthesis and biomedical applications. In the present study, the effect of interfacial tension on droplet size and droplet generation frequency is observed using COMSOL Multiphysics® software. To observe the variation in droplet size and generation frequency, interfacial tension is varied from 5 mN/m to 30 mN/m. Experimentally, interfacial tension can be varied by changing the concentration of the surfactant added to continuous/dispersed phase. As the concentration of the surfactant increases, interfacial tension decreases. The present work is limited only to the numerical investigation of the interfacial tension effect in W/O emulsions with water as dispersed phase and oil as the continuous phase. In this study, laminar two-phase flow level set method is used. Since the droplet generation in T-junction microfluidic device takes place when viscous force by flowing stream of continuous phase overcomes the surface tension force. From scaling analysis, it is found that droplet diameter scales as the reciprocal of the Capillary number. Keeping the other parameters such as the velocity of flowing streams, viscosity, channel width/diameter constant, droplet diameter is expected to increase with the increase in interfacial tension. Similar effects have been studied experimentally on Flow focusing device by Lu Peng et al. [1] and on T-junction by Shazia et al. [2]. The results obtained for different interfacial tension are following the expected variation. It is observed that with increasing interfacial tension droplet size is increasing and droplet generation frequency is decreasing. It can be concluded from the study that interfacial tension variation due to surfactant concentration control will consequently manipulate the droplet size.

Reference

1. Lu Peng et al. “The effect of interfacial tension on droplet formation in flow-focusing microfluidic device”, Biomed Microdevices, 13:559–564 (2011).
2. Shazia et al. “Dynamic Wetting in Microfluidic Droplet Formation”, Biochip J. 8(2): 122-128 (2014)

Figures used in the abstract

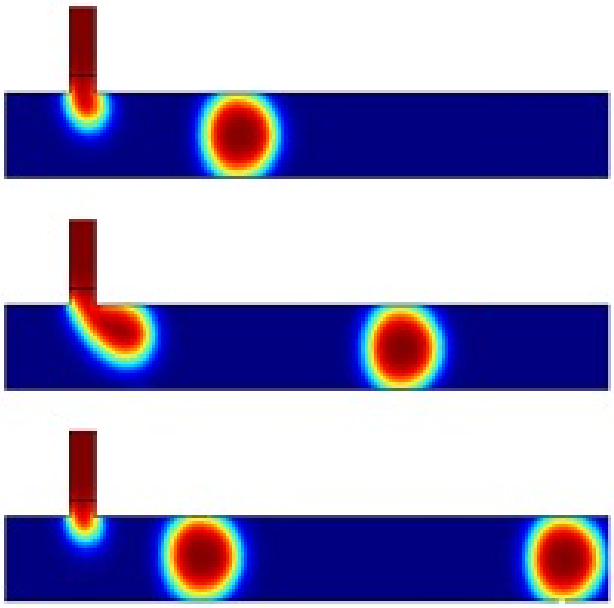

Figure 1: Droplet generation (W/O emulsion) in T-junction microfluidic device