Formation and transport of bubbles and droplets at low capillary number

Volkert van Steijn[1*]

[1] *Delft University of Technology, Faculty of Applied Sciences, van der Maasweg 9, 2629 HZ, Delft, the Netherlands*
v.vansteijn@tudelft.nl

Droplets forming in and moving through confined spaces are as common as the liquid bridge that forms when turning a page with a wet finger, and they are at the heart of a wide variety of large-scale industrial processes, including the recovery of oil from porous rocks. An emerging field of application is droplet microfluidics, where confined droplets are used to make advanced materials, sequence single cells, or discover therapeutics. For almost all of these applications it is important that the behavior of bubbles or droplets in a network of microchannels is well understood.

The physics of droplet formation and transport in microchannel geometries is relatively well understood for capillary numbers in the range 10^{-3} -10^{-1}.[1] The first part of this talk focuses on droplet formation and breakup at much lower capillary numbers. An interesting feature of low Ca flows of bubbles and droplets under strong confinement is the ability for the continuous phase to flow around them.[2] As shown in this talk, these flows drastically alter the mechanisms governing the formation and breakup of droplets.[3]

While the first part of the talk focuses on the dynamics of sharp interfaces, the second part focuses on interfaces with a diffuse nature. One example includes the formation of droplets from two aqueous phases containing different types of polymers [4, 5] ,while a second example focuses on the velocity field around nanoscopic sessile droplets.

References

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