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Neck Thinning Dynamics of Janus Droplets under Multiphase Interface Coupling in Cross Junction Microchannels

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Abstract : Necking processes of the Janus droplet generation in the cross-junction microchannels are experimentally and theoretically investigated. The two dispersed phases that are simultaneously shear by continuous phases are liquid paraffin wax and 100cs silicone oil, in which 80% glycerin aqueous solution is used as continuous phases. According to the variation of minimum neck width and thinning rate, the necking process is divided into two stages, including the two-dimensional extrusion and the three-dimensional extrusion. In the two-dimensional extrusion stage, the evolutions of the tip extension length for the two discrete phases begin with the same trend, and then the length of liquid paraffin is larger than silicone oil. The upper and lower neck interface profiles in Janus necking process are asymmetrical when the tip extension velocity of paraffin oil is greater than that of silicone oil. In the three-dimensional extrusion stage, the neck of the liquid paraffin lags behind that of the silicone oil because of the higher surface tension, and finally, the necking fracture position gradually synchronizes. When the Janus droplets pinch off, the interfacial tension becomes positive to drive the neck thinning. The interface coupling of the three phases can cause asymmetric necking of the neck interface, which affects the necking time and, ultimately, the droplet volume. This paper mainly investigates the thinning dynamics of the liquid-liquid interface in confined microchannels. The revealed results could help to enhance the physical understanding of the droplet generation phenomenon.

Keywords : neck interface, interface coupling, janus droplets, multiphase flow
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