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Control over the shell thickness of core/shell drops in three-phase glass capillary devices

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Abstract:

Core/shell drops find uses as templates for the production of core/shell particles and functional vesicles, such as liposomes, polymerosomes and colloidosomes. In this work, monodisperse core/shell drops with a controllable shell thickness were produced using microcapillary device shown in Figure 1. This device consists of two circular capillaries with a tapered end inserted into a square capillary. Milli-q water was supplied through the injection tube with an orifice diameter of 44 μm . A mixture of 2 % (w/w) Dow Corning 749 Fluid in 10 cP PDMS was supplied as a middle fluid through the square capillary in the same direction. The continuous phase was an aqueous solution containing 2 % (w/w) poly(vinyl alcohol) and 40% glycerol. The continuous phase liquid was supplied from the opposite side through the square capillary and all three liquid streams were forced into the collection tube with an orifice diameter of 115 μm . It resulted in the rupture of coaxial jet composed of inner and middle fluid and the formation of discrete core/shell drops. In order to prevent wetting of the injection tube with water, the tapered section of the injection tube was rendered hydrophobic with octadecyltrimethoxysilane. The shell thickness ranged from several μm to several tens of μm and was controlled by adjusting the ratio of the middle liquid flow rate to the inner liquid flow rate (Fig. 1). The drop generation frequency was in the range from 1,000 to 10,000 Hz and the drop diameter varied between 60 and 150 μm . The drop size and generation frequency were controlled by changing the flow rate of the continuous phase in the range from 10 to 45 mL h^{-1} .

Fig. 1. Control over the shell thickness of core/shell droplets in glass capillary devices by changing the ratio of the middle fluid flow rate Q_m to the inner fluid flow rate Q_i . The orifice size of the injection tube was 44 μm .

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