Fabrication of biodegradable poly(lactic acid) particles in flow focusing glass capillary devices

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Poly(dl-lactic acid) (PLA) particles with a diameter in the range from 12 to 100 μm were fabricated in flow focusing glass capillary devices shown in Figure 1. The disperse phase was 5% (w/w) PLA in dichloromethane (DCM) containing small amount of nile red and the continuous phase was 5% (w/w) poly(vinyl alcohol) in milli-Q water. The two immiscible liquids were introduced from the two ends of the same square capillary in opposite directions and both liquids were collected and exit through the inner circular capillary. The disperse phase was hydrodynamically flow focused by the continuous phase in the tapered section of the circular capillary, which caused the disperse phase to break into drops inside the collection tube. PLA particles were formed by DCM evaporation at room temperature. In order to prevent wetting of the collection tube with the disperse phase, the hydrophilicity of the glass surface was enhanced by 2-[methoxy(polyethyleneoxy)propyl]trimethoxysilane. Experimentally, we show that the droplet size is influenced by the operating conditions and orifice size, as shown in Fig. 1. The drop formation occurs near the orifice in the dripping regime (Fig. 1a-b) and farther downstream in the jetting regime (Fig. 1c). The drops formed in the jetting regime are significantly bigger than those formed in the dripping regime and have a broader size distribution.

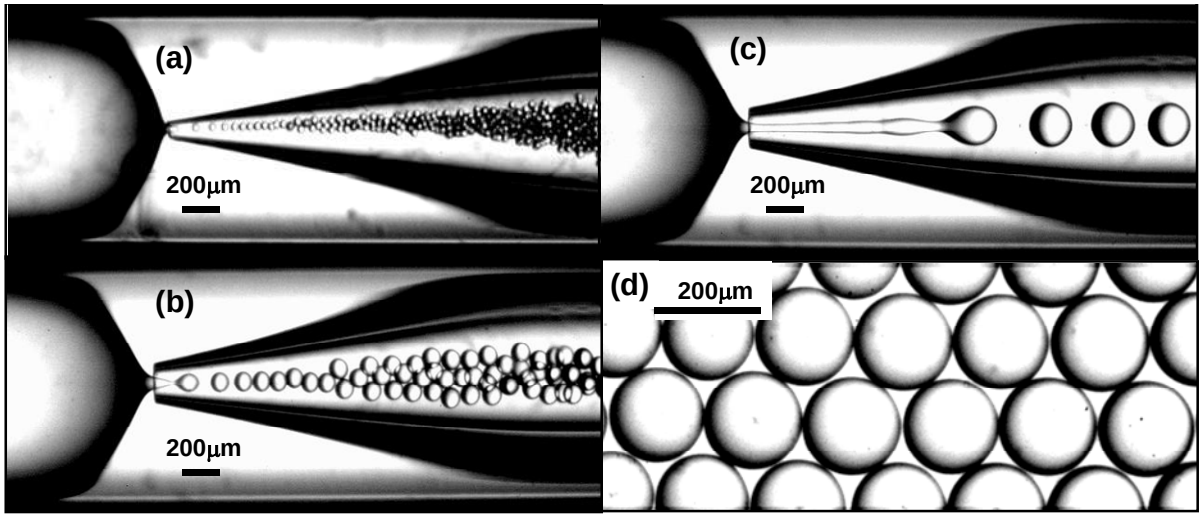

Fig. 1. (a) Q_c=0.5 mL h^{-1}, Q_d=0.003 mL h^{-1}, $d_{orifice}$=60 μm, $d_{droplet}$= 33 μm. (b) Q_c=5 mL h^{-1}, Q_d=1 mL h^{-1}, $d_{orifice}$=130 μm, $d_{droplet}$= 100 μm. (c) Q_c=6.5 mL h^{-1}, Q_d=0.7 mL h^{-1}, $d_{orifice}$=130 μm, $d_{droplet}$=230 μm. (d) Collected monodispersed droplets.

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