Novel single-step microfluidic strategies for production of patched and Janus bipolymer microparticles

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Monodispersed biodegradable bipolymer particles composed of poly (DL-lactic acid) (PLA) and polycaprolactone (PCL) with patched (Fig. 1e), Janus (Fig. 1c), and patched Janus (Fig. 1a,b,d) morphologies have been produced in a single-step microfluidic process using glass capillary and single-crystal silicon microchannel (MC) array devices. The morphology of the particles was determined by the degree of separation of the two polymers in the solid phase, which was controlled by the relative rates of solvent removal and polymer interdiffusion.

In flow focusing glass capillary and MC array devices, PLA and PCL were premixed in the solvent blend before droplet generation. In a co-flow/flow focusing glass capillary device, PLA and PCL were supplied from two separate co-flow streams and mixed together within a formed droplet. The degree of polymer separation increased with increasing dichloromethane (DCM)-to-ethyl acetate (EA) ratio in the dispersed phase from 25:75 to 50:50 to 75:25, because of the lower solubility of DCM in the aqueous phase, which supressed solvent evaporation. The particle morphology was investigated by confocal laser scanning microscopy (CLSM) using the fluorescence dyes Nile Red and Rhodamine 6G, which were preferentially adsorbed onto PLA and PCL, respectively.

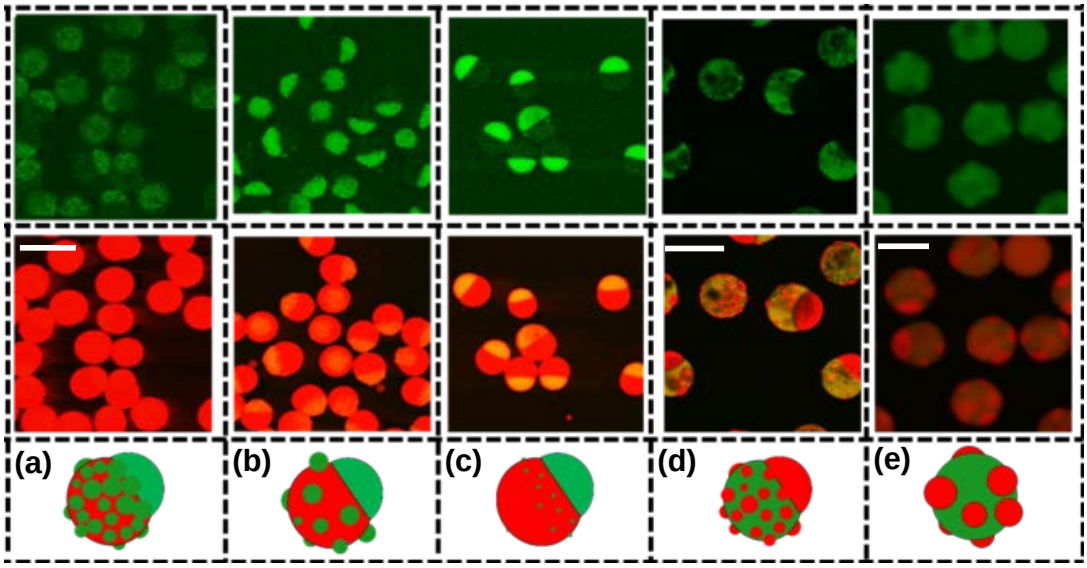

Figure 1. CLSM images of patched particles formed using (a-c) flow focusing; (d) co-flow/flow focusing; (e) microchannel array devices: (a) DCM:EA=25:75, PCL:PLA=1:2; (b) DCM:EA=50:50, PCL:PLA=1:2; (c) DCM:EA=75:25, PCL:PLA=1:2; (d) Solvent micromixing (DCM:EA=40:60, PCL:PLA=1:7.5); (e) DCM:EA= 100:0, PCL:PLA=1:2. Scale bars: (a-c) 50 μm; (d) 100 μm; (e) 5 μm.

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