Microfluidic production of semipermeable microcapsules with regulated nanoporosity by polymerization-induced microphase separation

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Microcapsules with size-selective permeability have various applications including catalytic reactions and sensors. There are few reports to produce such semipermeable capsules, however, creating regular nanopores on the membrane of microcapsules with controlled pore size is still an important challenge. In this work, we report a facile approach to control nanoporosity of semipermeable microcapsules by employing microfluidics and polymerization-induced microphase separation (PIMS) methodology. Using glass capillary microfluidic device, monodisperse water-in-oil-in-water(W/O/W) double emulsions are generated; middle layer of double emulsion is composed of polymerization mixture of styrene, divinylbenzene (DVB), polylactic acid macro-chain transfer agent (PLA-CTA), and a thermal radical initiator. Microcapsules with crosslinked PS-b-PLA membrane with a bicontinuous morphology are produced by reversible addition-fragmentation chain transfer (RAFT) process. After removal of PLA domain at basic condition, nanoporous microcapsules are obtained. Pore size and size-selective permeability of the capsules are controlled at the sub-10 nm scale by differentiating the molar mass of PLA.