Microfluidic design of tailored microcapsules with selective permeability

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Microcapsules have been widely used in various applications including pixellation of display pigments and self-healing materials. Advanced functionality can be achieved by perforating capsule membrane; microcapsules with such membranes have size-selective permeability which is potentially useful for controlled release and immunoisolation. However, conventional approach to produce semipermeable capsules lacks controllability of capsule size and efficiency of encapsulation. In this work, we report a new microfluidic strategy to create microcapsules with selective permeability to overcome the shortcomings of conventional approaches. With capillary microfluidic devices, monodisperse water-in-oil-in-water double-emulsion drops, whose ultra-thin middle layer is composed of photocurable resin and porogen, are generated. Upon UV illumination on the drops, the monomers are polymerized, resulting in phase separation between the polymerized resin and porogen within the ultra-thin shell. Subsequent dissolution of porogen leaves behind regular pores, thereby providing size-selective permeability; a cut-off value of permeability is controlled by degree of the phase separation.