Microfluidic design of functional polymersomes

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Polymersomes, consisting of aqueous core and bilayer membrane of amphiphilic block-copolymers, are very useful as microcarriers in various biological delivery systems; the artificial polymeric membrane has higher stability and lower permeability than that of liposomes, thereby ensuring the long-term storage without a leakage. However, conventional approaches to make the vesicular structures, such as electroformation or bulk hydration of dried amphiphiles, achieve only limited control over size and low efficiency of encapsulation. In this work, we report microfluidic approaches to overcome such limitations and provide enhanced functionalities of the polymersomes. With capillary microfluidic devices, we prepare water/oil/water double-emulsion drops as templates for the polymersomes. The unilamellar polymersomes are produced by dewetting of the amphiphile-laden oil phase from the surface of the innermost water drop of the double-emulsion templates. Further development of microfluidic devices enables to design multiple polymersomes, polymersomes-in-polymerosmes, providing encapsulation and programmed release of multiple distinct components.