Tailored microcapsules made through microfluidics

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Filled capsules feature prominently in applications involving delivery and controlled release of encapsulated materials in medicine, cosmetics and the food industry. For such functions, the mechanical stability and permeability of those capsules play a vital role. Capsules are routinely formed using emulsification of two immiscible liquids followed by interfacial polymerization, giving a thin and dense polymer shell [1], or by interfacial adsorption of colloidal particles, leading to colloidosomes [2]. Tuning the size, shell thickness and composition is crucial for the design of capsules with controlled strength and permeability, but is often difficult to achieve with current methods.

In our work, we produce controlled double emulsions with established microfluidic techniques [3] and combine those with an in situ polymerization of one of the fluids to yield composite capsules with controlled sizes down to 100 µm, variable shell thicknesses and variable chemical composition (see Fig. 1).

![Fig. 1: Monodisperse capsules with a polyacrylate-silica composite shell (a). Manual handling (b) and rupture (c) of capsules filled with polystyrene nanoparticles.](image)

We fabricate the microfluidic devices using commercially available glass capillaries and generate the double emulsions by carefully adjusting the flow rates of the respective liquid phases. The middle fluid phase, which later forms the capsule shell, contains an acrylate monomer, silica particles and a photoinitiator. We then induce the polymerization using a UV light source, which leads to capsule formation within less than a minute. By adding a suitable contrast material to the innermost fluid phase, we confirmed its encapsulation through optical microscopy and observed the content release of our capsules by manual rupture. Current activities are now focused on the evaluation of the mechanical strength and permeability of capsules with deliberately tuned size, shell thickness and shell composition.