

STIMULI SENSITIVE MICROCAPSULES WITH MACROPOROUS POLYMER SHELLS

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Porous microcapsules are of great interest in diverse applications, ranging from encapsulation for controlled release, to catalyst support to filtration and purification systems in analytical science.

Here, we demonstrate a novel method to obtain porous microcapsules with polymer shells whose macroporosity and mechanical properties can be tuned within a wide range. Microcapsules are produced by microfluidics, using a co-flow flow-focusing glass capillary device to make water-oil-water (W/O/W) double emulsion templates. A mixture of acrylate monomers (glycidyl methacrylate and ethylene glycol dimethacrylate) and porogens (phthalate-based, alkanes or linear alcohols) is used as oil phase. Heterogeneous polymerization of the acrylate monomers leads to a biphasic structure in the capsule shell, in which a network of polymer beads is permeated by the liquid porogen. In the presence of hydrophobic porogens, the formation of a thin and tight polymer skin is observed on the inner and outer surfaces of the shell. This leads to sealed pores within the shell of the microcapsules, which can be used for the storage of chemicals in addition to the main encapsulant in the capsule core. As a proof of concept of such co-encapsulation of reactive compounds, we produced capsules loaded with separately stored monomers commonly used for two-components epoxy resins. Such capsules provide a rich platform for the design of solid adhesive and self-healing materials. Furthermore, the utilization of porogens with low boiling point, such as a short alkanes, leads to thermosensitive capsules that explosively release their content within seconds. Combining these capsules with magnetic particles heated by magnetic hyperthermia, we achieved a magnetic release of the capsules content within seconds and without over-heating the surrounding matrix. Incorporation of glycidyl methacrylate monomers results in polymer capsules with epoxy-functionalized surfaces, which can be further reacted with amine-based functional compounds. Exploiting such epoxy groups as anchors for grafting of sensitive polymers and for covalently attaching nanoparticles, we prepared multi-functional capsules with tailored shell structure and surface chemistries.

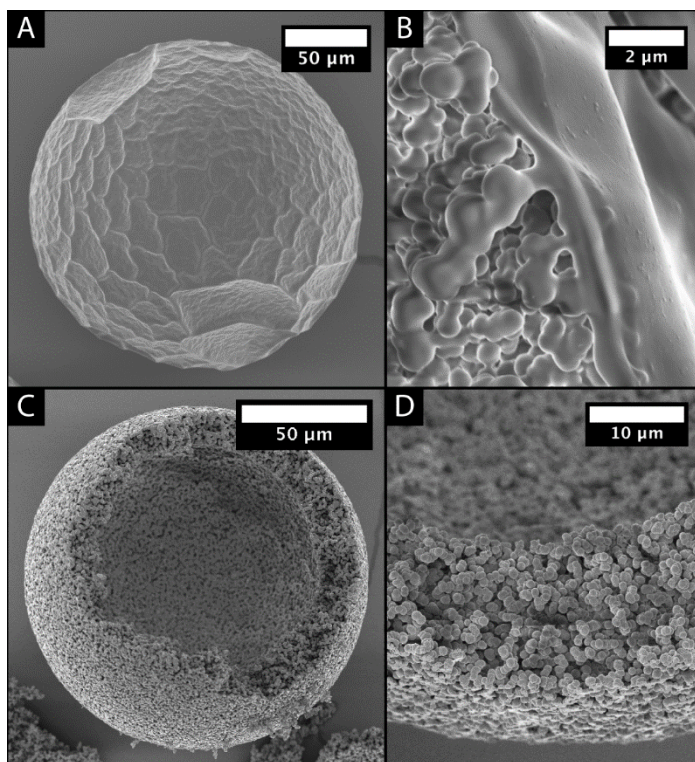


Figure 1 – A and B: Skin formation on capsules produced with 35 wt % of diisodecylphthalate. C and D: Open porous structure on capsules produced with 30 wt % undecanol.

