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## Templating of Nanostructured Materials from Self Assembled Fluorinated Surfactants

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Control over pore size, shape, and functionality is essential to the development of nanostructured materials for catalysis, chemical separations, chemical and biochemical sensing, and electronic applications. Synthesis of ceramic materials based on a combination of sol-gel chemistry (the liquid-phase reactions of alkoxysilane precursors to generate silica) and surfactant templating provides many opportunities to tailor the structure of the pores as well as the form of the material (i.e., monoliths, hollow spheres, microparticles, and thin films). Ordered silica material is synthesized through the co-assembly of surfactant templates with hydrolyzed alkoxysilane precursors. Polymerization of the precursor and subsequent surfactant removal results in pore structures that mimic the surfactant mesophase. Researchers have previously synthesized mesoporous silica using a wide variety of hydrocarbon surfactant or block copolymer templates.

We demonstrate the synthesis of nanostructured material and the control of pore structure using fluorinated surfactants. Fluorocarbons are more hydrophobic than hydrocarbons, which causes them to self-assemble more readily than analogous hydrocarbon surfactants. The bulkiness of fluorocarbon surfactant tails relative to hydrocarbons leads to surfactant aggregates with lower curvature. These unique properties of fluorinated surfactants as templates are exploited to form unusually small uniform pores, to capture novel structures, and to vary accessibility of organic and fluorocarbon functional groups within the pore structure. Refinement of the pores with $CO_2$ processing, which makes use of the $CO_2$-philic nature of fluorocarbon surfactants, is demonstrated. The ability to translate the rich phase behavior of surfactants to tunable nanostructures is further explored in the transcripting templating of silica hollow spheres from fluorinated vesicles and in the molecular imprinting of ceramics from mixed surfactant templates.

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