Control of mass transfer from silica particles

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Porous hard shell particles have been the subject of broad interest for their potential applications in drug and other chemicals delivering. Silica has been demonstrated to be an ideal host for biopolymer encapsulation since it is chemically and thermally stable and can limit the effect of the outside environment on the particles core. Other advantages of silica include biocompatibility and porosity, which offers the possibility to regulate diffusion.

The aim of this work is to synthesize silica (SiO2) microparticles with specific controllable shell structure to act as an outer layer of the so-called chemical robots or their internal compartments. Chemical robots can be defined as microscopic particles with simple intelligence, covered by a porous membrane able to regulate molecular transport into and out of their interior that contains compartments carrying different kinds of molecules.

Two types of particles were prepared:
- Silica-coated alginate particles. Silica shell on alginate gel beads was synthesized by layer by layer technique using sol-gel process of alkoxysilane precursor (tetramethoxysilane (TMOS) and aminopropyltrimethoxysilane (APTS)) which resulted in a alginate/aminopropylsilicate/SiO2 complex [1].
- Silica hollow spheres. Hollow silica micro particles were synthesized through a template method, where the SiO2 from a silica source tetraethyl orthosilicate (TEOS) precipitates around octylamine (OA) microdrops or polystyrene beads (PS). The template is subsequently removed through dissolution or calcination, thus forming the silica hollow structures [2, 3].

The particles morphology was characterized via various methods: scanning electron microscopy (SEM), optical microscopy (OM) and X-ray tomography (SkyScan's Micro-CT). Diffusion properties of the silica were studied by measuring the release kinetics of a model substance (methylene blue, vitamin B12, biomacromolecule) out of the shell using UV/VIS spectroscopy detection. The molecules with increasing molecular weigh were chosen in order to determine molecular weigh cut off for the silica shell. The further adjustment of porous shell (control of pore size distribution, additional surface modification by “polymer brushes”) will be also discussed.