IRON OXIDE @ SILICA AEROGEL PARTICLES SYNTHESIZED IN SUPERCRITICAL FLUIDS

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Iron oxide nanoparticles are interesting magnetic materials with multiple areas of application such as biomedical applications, data storage and processing, sensors and magnetic seals. Concerning biomedical applications, the ones gathering more interest are those related to drug guidance and delivery, magnetic separation of biomolecules, tumour treatment by magnetic hyperthermia and contrast enhancement agents for magnetic resonance imaging (MRI).

All these biomedical applications require that these nanoparticles are ferro- or superparamagnetic, biocompatible, non-toxic and, very important, stable in colloidal state when dispersed in water at physiological conditions (pH, ionic strength, cell interactions, etc.). To ensure the colloidal stability, particle aggregation due to magnetic or chemical interactions must be avoided. To this purpose, the particles are usually coated with surfactants, electrolytes, and/or polymers, which create steric or electrostatic repulsions between the particles, thus ensuring their dispersion.

Silica is frequently chosen as an inorganic polymeric coating because of its biocompatibility, chemical stability in water and high porosity and surface area. Moreover, the silica coated magnetic nanoparticles can be further modified through the surface silane bonds and thus, extend the functionalities of the composite. High porosity of the silica coating is important since drugs can be loaded in the pores and delivered to a specific site using magnetic fields. Large surface areas will guarantee a larger number of available sites for functionalization.

There are several methods to coat nanoparticles with silica, such as the Stöber method, microemulsion technique and aerosol pyrolysis. When using these methods non-porous silica is obtained. Surfactants can be added to generate porosity, as in the case of ordered mesoporous silica MCM-materials. In such a case, the surfactant has to be eliminated adding one extra step to the synthesis.

We have developed a simple one step sol-gel synthesis in supercritical conditions to fabricate porous core-shell magnetic nanoparticle@silica composites. In supercritical conditions, the solvent is extracted in supercritical phase thus avoiding the capillary pressure that would collapse the pores if extracted in liquid phase (drying the material at atmospheric pressure). The resulting silica shell is aerogel-like exhibiting high surface area and high porosity and with no need to add surfactants.

The resulting material, which can be seen in the TEM image in Figure 1, shows the sub-micrometric composite particles formed by a magnetic core of iron oxide nanoparticles and a silica aerogel-like shell. Their physico-chemical and magnetic properties will be also presented. The material can be envisaged to be suitable for several biomedical applications in particular, as contrast agent for MRI.

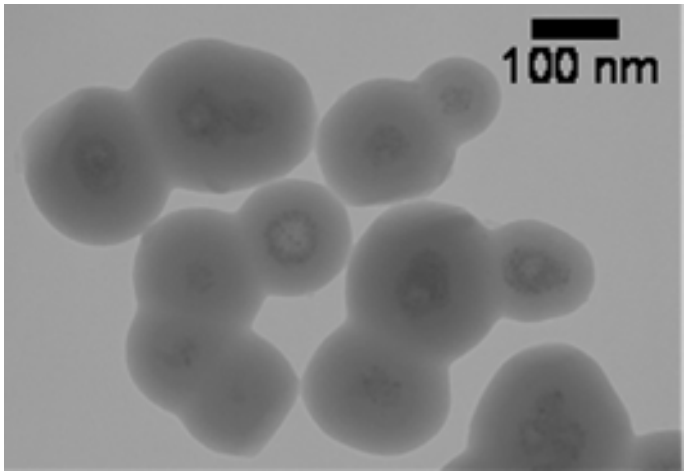

Figure 1: TEM image of the composite microparticles.

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