Poster

SYNTHESIS AND FUNCTIONALIZATION OF SILICA NANOPARTICLES WITH HYDROPHILIC OR HYDROPHOBIC GROUPS

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Different organic materials such as polymeric nanoparticles, liposomes, and micelles have been studied as possible vectors for bio-applications. In order to offer an alternative to the biodegradable (i.e., polyesters) and no-biodegradable (i.e., methacrylate) polymeric micro and nanoparticles as carriers, the use of silica has been proposed based on its non-toxicity and biocompatibility, its high chemical and mechanical stability and its hydrophilic character, and porous structure that can, in principle, be tailored to control the diffusion of an adsorbed or encapsulated molecule.

In this work, silica particles functionalized with different organic groups have been synthesized and characterized in order to study their potential application as gene and drug delivery carriers.

First, silica nanoparticles with uniform particle size were synthesized and characterized [1]. A hydrophilic functionalization of the mesopores was obtained by using 3-aminopropyltriethoxysilane (APTES) as source of amino groups. The conjugation was done following a co-condensation method [2]. The content of amino groups was determined by a colorimetric method [3]. The zeta potential of the functionalized nanoparticles was evaluated by using Photon Correlation Spectroscopy (PCS) (Figure 1). Rhodamine B isothyocianate was covalently bonded to the amino functionalized nanoparticles.

The same procedure was used in order to obtain hydrophobically modified silica nanoparticles by using methyltrimethoxysilane (MTMS) (Figure 2). Fourier Transformed Infrared Spectroscopy (FTIR) analysis (Figure 3) was used to corroborate the presence of surface methyl groups as well as the absence of any of the structure directing agent (hexadecyltrimethylammonium bromide, CTAB) used in the synthesis of the mesoporous silica nanoparticles. A catalytic chamber was used to avoid the interferences caused by the hydroxyl groups of water. Adsorption isotherms of rhodamine B on the methyl-functionalized silica nanoparticles were calculated by using spectrophotometry.

The influence of the solvent (methanol and water) was study in the adsorption of rhodamine B on the hydrophobically modified nanoparticles by using a dynamic and a discontinuous system, respectively. No adsorption was observed using methanol as solvent. Indeed, the opposite effect was obtained with water. The dynamic adsorption was tracked by using a UV-Visible spectrophotometer equipped with a photo diode array detector. The advantage of an array is the ability to do side-by-side readings, thus increasing speed.

A complete characterization of all the nanoparticles used in this work was performed by analyzing their particle size and morphology with Photon Correlation Spectroscopy (PCS) and Scanning Electron Microscopy (SEM), respectively. The structural characterization and porosity and surface area was evaluated by using Small Angle X-Ray Scattering (SAXS) and Nitrogen Adsorption Isotherms (BET). Fourier Transformed Infrared Spectroscopy (FTIR) was used to monitor the presence or absence of the functional groups.

References:

[1] Clara Yagüe, María Moros, Valeria Grazú, Manuel Arruebo, Jesús Santamaría, Chemical Engineering Journal, (2007) In press.
[2] Wei Zeng, Xue-Feng Qian, Yan-Bo Zhang, Jie Yin, Zi-Kang Zhu Zeng, Materials Research Bulletin **40** (2005) 766–772.
[3] Ian J. Bruce and Tapas Sen, Langmuir **21** (2005) 7029-7035.

Figures:

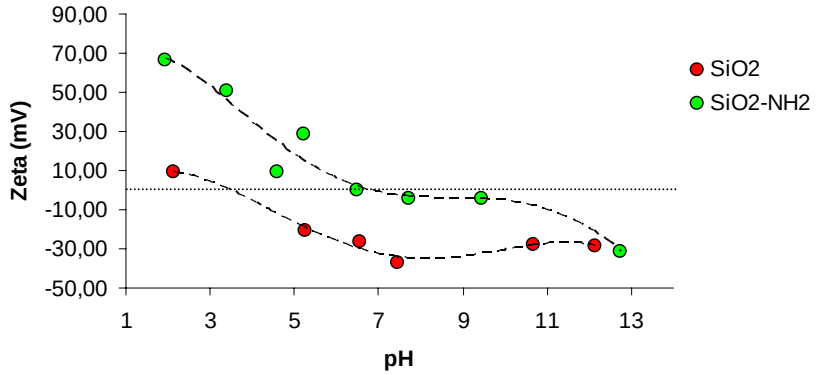

Figure 1. Zeta potential of amino-functionalized silica nanoparticles.

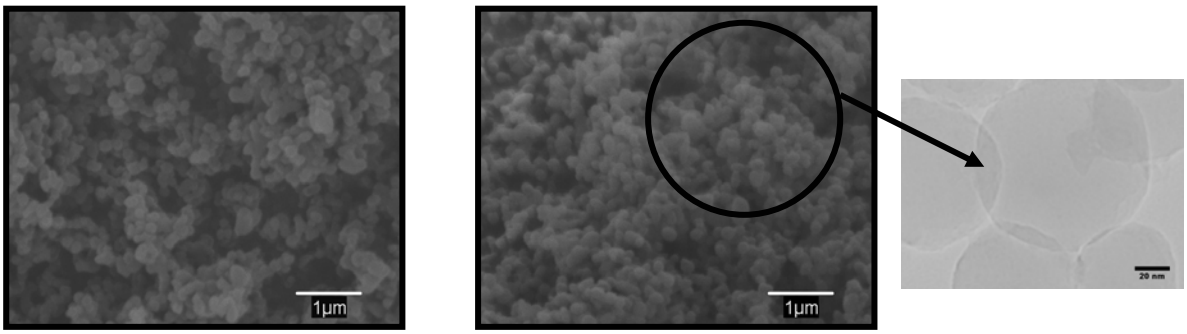

Figure 2. SEM photographs of silica particles hydrophobically modified with methyl groups.

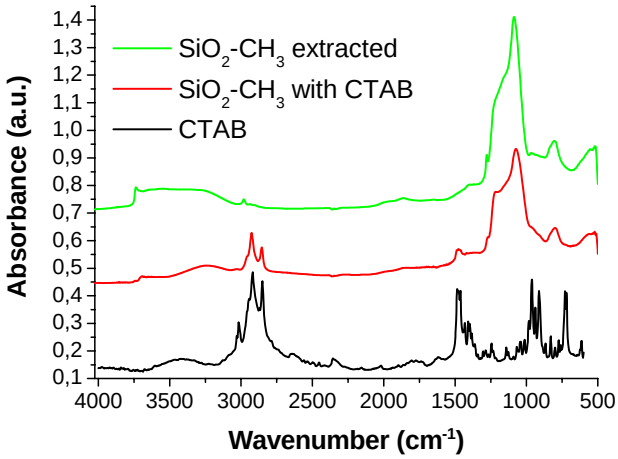

Figure 3. FTIR spectra of modified nanoparticles as-synthesized and after extraction of CTAB.