Hybrid silica based materials for drug delivery applications

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Silica based nanomaterials represent one of the most studied classes of nanosystems for imaging and drug delivery. In particular, mesostructured materials have attracted increasing attention since their synthesis allows precise control of the features and morphology. For these reasons mesoporous systems are considered to be ideal candidates as host materials to guest organic molecules, producing organic-inorganic hybrid materials. Traditionally, mesostructured materials were used as supports in heterogeneous catalysis and as molecular sieves. In the last decades, these systems were widely explored as carriers for drug delivery and, more recently, as host for fluorescent organic dyes and organometallic complexes due to their applications in bioimaging, optoelectronics, as sensor devices, etc.

Extensive research work on the preparation and functionalization of ordered mesostructured silica nanoparticles for stimuli responsive release and bioimaging have been carried out in the SURFIN (Surfaces and Interfaces Physical Chemistry Group) of the Chemistry Department of Turin University.

The approach is particularly focused on the study of the phenomena occurring at the interface of the materials. The work includes synthesis of the materials and optimization of the loading procedure with respect to the selected drug. A detailed physico-chemical characterization is thus carried out, with particular attention to the interaction of the materials surface with the drug or with water, to assess their hydrophilic character. In situ infrared spectroscopy (when needed coupled to solid state Nuclear Magnetic Resonance, SS NMR) is particularly useful to provide detailed information on the kind of interactions taking place at the material interface. The molecular information obtained by these techniques (hydrogen bonding interactions and acid-base equilibria between the surface and the environment or within organic and organic moieties of the surface) can be moreover, complemented by quantitative microgravimetric measurements.

This physico-chemical activity, strongly related to a better understanding of the inorganic-organic interface, is complemented by studies of the prepared materials as drug delivery systems (DDS), including release tests in different media (including simple pharmaceutical applications) and (in the case of nanosized materials) in vitro tests to evaluate internalization in cells, toxicity and/or efficacy of the developed systems.