Nanoporous ceramic particles as containers for anti-corrosion agents and their use in active self healing anticorrosion coatings

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Corrosion is one of the major destruction processes involved in materials loss, and its prevention is of paramount importance in protecting investments. A new generation of anticorrosion coatings that both possesses passive matrix functionality and responds actively to the changes in the local environment has attracted great interest of material scientists. The key element of a new generation of protective self healing-coatings is the embedding of smart nano- or microcontainers loaded with the inhibitor into the coating matrix. In this way a completely new coating of the “passive” host- “active” guest structure can be designed. The most important part in the design of such active coatings is to develop nanocontainers with good compatibility to the matrix components, possibility to encapsulate and store active material and permeability properties of the shell controlled by external stimuli.

In this work we present the synthesis of different SiO$_2$ and TiO$_2$ nanocontainers using a sol-gel process and their characterization by different methods. SiO$_2$ nanocontainers can be synthesized as highly porous MCM-41 like spherical particles\cite{1} using surfactants as structure directing agents. These materials have surface areas bigger than 1000m$^2$.g$^{-1}$, pore volume of ca. 1 cm$^3$.g$^{-1}$ and particle sizes between 100 and 300nm. TiO$_2$ nanocontainers are synthesized using a combined approach of modified titanium alkoxide precursors\cite{2} and controlled hydrolysis either in a W/O or O/W emulsion. Moreover we synthesized spherical hollow silica particles with porous shells from O/W emulsions. The obtained spheres are highly monodisperse with a tunable size in the range of 200 to 800nm.

![Image](a) spherical porous SiO$_2$ particles with 2D hexagonally ordered cylindrical pores  
(b) spherical hollow SiO$_2$ particles with porous shell.

In a second step the corrosion inhibitors are embedded into the nanoporous containers. These materials are able to uptake a huge amount of corrosion inhibitor and release them in a sustainable way. We also synthesized core-shell particles consisting of hydrophobic corrosion inhibitor in the core and silica in the shell from O/W Emulsions. This type of containers is a very promising system since the fabrication of containers and the encapsulation of the inhibitor occurs only in one step making this process time and cost saving.