Mesoporous Silica Nanocontainers: State of Art and Outlooks

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The problems of encapsulation of various functional substances (first of all, water-insoluble or slightly soluble ones), as well as their controlled release, are of great importance for biomedicine, pharmaceutics, material protection, etc.

Here we discuss the prospects for solving these problems using mesoporous silica nanocontainers (MSNs) prepared by the sol–gel method. We are focused on the new concept of encapsulation of amphiphilic functional compounds which have been developed by us earlier. It is based on the using of associates (micelles or vesicles) of these substances (instead of similar associates of "inert" surfactants) as templates in MSNs synthesis. This allows us to combine the stages of the MSNs synthesis and their loading with such functional substances and to provide their very high content in the particles. The benefits of this approach are demonstrated using a wide range of amphiphilic compounds, including antiseptics, an anticancer drug and corrosion inhibitors.

The effects of the template structure and sol–gel conditions on the morphology and loading capacity of MSNs are analyzed quantitatively.

The main features of the templating functional substance's release from the MSNs into the aqueous environment are studied, and a mechanism of this process is proposed. It is shown that the templating substance release is determined by the solubility and/or swelling of the silica matrix under the action of penetrating water and the interaction of its molecules/ions with the pore walls of the MSNs. The rates of these processes are strongly dependent on the medium pH.

The bactericidal activity of encapsulated antiseptics against the *Staphylococcus aureus* is evaluated *in vitro* by agar diffusion method.

The possibility of sol–gel synthesis of multifunctional MSNs using the "hybrid" templates, which are presented by the micelles of antiseptics containing solubilized hydrophobic drug, has been demonstrated.

It is revealed that the MSNs which have been prepared using the corrosion inhibitor micelles as templates can be easily incorporated into the paint and varnish coatings (in contrast to "pristine" inhibitor). Such coatings provide a very effective protection of low-carbon steel and D16 aluminum alloy against corrosion even under severe conditions of neutral salt spray.

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