New concept of mesoporous nanocontainers synthesis and loading

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Mesoporous silica nanoparticles (MSNs) are characterized by a large specific area and an ordered system of pores which diameter can be varied from 2 to 50 nm. Such particles are of significant interest as nanocontainers for different substances, primarily – for drugs [1]. The main approach of the MSNs'creating is a sol–gel synthesis using "*inert*" surfactant micelles as a template. After the synthesisis completed, the template is removed by chemical etching or high-temperature treatment of the MSNs and a targeted functional compound is loaded.

The drawbacks of this classical scheme are its multistage nature and a relatively low uptake of the targeted substance by silica vehicles; generally it does not exceed 0.3 g per 1 g of SiO_2 [2]. Moreover, in most cases, it is necessary to modify the inner/outer surface of the MSNs by grafting some functional compound; this allows one to control the sorption kinetics of the targeted substance and its release rate.

We propose a new approach that allows one to combine the stages of silica nanocontainers synthesis and their loading with the targeted substance. Moreover it is greatly facilitate the control of the uploaded substance release without any additional modification of the nanocontainers' internal or external surface.This approach is based on the use of micelles (or vesicles) of the *targeted substance itself* (instead of *inert* surfactant ones) as templates in the MSNs synthesis [3, 4].

The prospects and benefits of such route are exemplified by the encapsulation of various functional amphiphilic compounds (for example, bactericidal drugs and corrosion inhibitors). Wherein,the possibility of silica nanocontainers synthesis using hydrolyzable drug as a templating agent has been demonstrated for the first time.

It is shown that the synthesizednanocontainers are characterized by an extremely high capacity with respect to templating functional compound (about 1 g and over per 1 g of SiO_2) and are also pH-sensitive.

The kinetics of the template molecules release from the MSNs has been studied at various pH and temperature values; and the features of this process in static and quasi-dynamic conditions have been analyzed.

We also discuss the possibility of such MSNs use as a basis to creation of protocells – fundamentally new means of drug delivery.

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1. H. Mekaru, J. Lu and F. Tamanoi, *Adv. Drug Delivery Rev.*, 2015, **95**, 40.
2. C. Bharti, U. Nagaich, A. K. Pal and N. Gulati, *Int. J. Pharm. Invest.*, 2015, **5**, 124.
3. O.V. Dement'eva, I.N. Senchikhin, E.M. Sedykh, I.N. Gromyak, V.A. Ogarev and V.M. Rudoy, *Colloid J.*, 2016, **78**, 52.
4. O.V. Dement'eva, and V.M. Rudoy, *RSC Adv.*, 2016, **6**, 36207.