Biosilica nanostructures synthesis and simultaneous CdTe quantum dots immobilization

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Abstract

In the nature, diatoms and sponges are able to take up silicon from the environment in soluble form as silicic acid, store it in the cell and catalyze its polymerization into silica with precise structure architecture down to nanoscale [1, 2]. This production of nanostructured silica in natural systems has been considered a process to mimic [3]. The interest in the biomimetic synthesis of silica-based materials is increasing, and in the last few years these phenomena has been an inspiration for the development of novel fabrication procedures in nanobiotechnology [4].
The mimetization of these natural phenomena minimizes the long reaction times and the multiple steps of complex protocols [2, 5]. Moreover, it avoids the use of harsh and environmentally unfriendly conditions such as toxic and expensive organic solvents, high temperature and pressure and high or low pH.
The processing of nanostructure particles in water under mild conditions, by using either synthetic or biologically-derived amine-containing macromolecules as additives, mediators or templates characterizes the biomimetic synthesis. The ability to manipulate all these conditions enables the controlling of the morphology of silica materials with a high level of precision and provides a powerful paradigm for the construction of biological nanostructures, involving other nanoparticles, such as quantum dots, with wide potential applications in the catalysis, diagnostic, therapeutic and biomedical fields.
Colloidal semiconductor nanocrystals or quantum dots (QDs) are monodisperse crystalline clusters of atoms with size normally comprised between 1 and 10 nm and with peculiars characteristics due to their low dimension [6]. In this work, CdTe quantum dots were synthesized, by wet chemistry using mercaptopropionic acid (MPA) as stabilizing agent by Zou's method [7] with some modifications.
Then QDs were encapsulated during the biosilica synthesis, a very rapid process (in seconds). Different parameters that could influence the biosilica particle synthesis and the QD immobilization were evaluated.
It was observed that some experimental conditions as silica precursors, catalysts, pH and anions concentrations influence the encapsulation efficiency and the size and the shape of biosilica nanoparticles (Figure 1). Moreover, it was also tested the stability and fluorescent character of quantum dots encapsulated in silica matrix (Figure 2).

References

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Figures

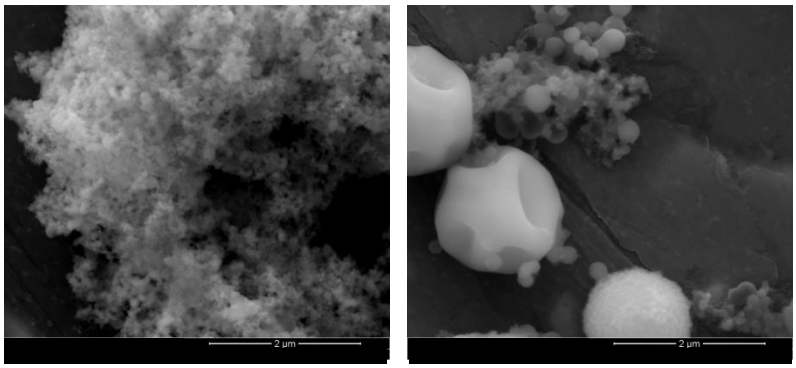

Figure 1 - Scan electron microscopy (SEM) images of synthesized QDs biosilica nanoparticles with different buffer conditions.

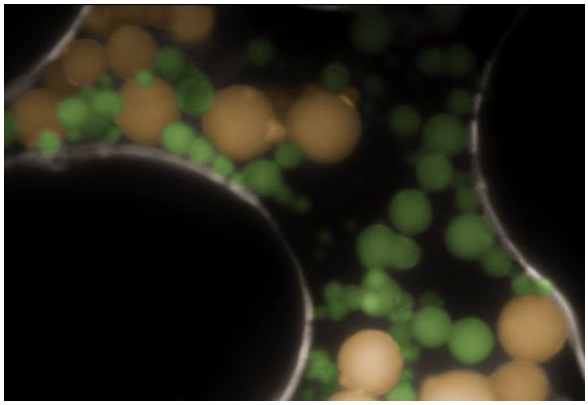

Figure 2 - Fluorescence microscopy image of biosilica with immobilized CdTe-MPA quantum dots.