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STABILIZATION OF QUANTUM DOTS ON MODIFIED NATURAL ALUMINOSILICATE NANOTUBES FOR BIOLOGICAL APPLICATION

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Stabilization of quantum dots on modified natural aluminosilicate nanotubes for biological application

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Andrei A. Novikov, Ph.D. in Chemistry, is a Senior scientist, and Assistant professor at Dept. of Physical and Colloid Chemistry, Gubkin University, Moscow, Russia.He is teaching the classes: "Physical Chemistry", "Kinetics and Catalysis", "Surface Phenomena and Disperse Systems", "Biotechnology in Oil and Gas Industry", "Advanced Physical Chemistry". Under his supervision, 2 master's theses are presented each year.His research group develops express methods of identification of microbes, including lipid analysis and SERS studies. Interests: metrology, regression analysis, and developing the scripts in GNU/Octave and Matlab for automated spectra processing.

Abstract

Introduction

Metal chalcogenides quantum dots (MChQDs) are of great interest due to tunable optical properties depending on the size and chemical composition. MChQDs for bioimaging are often synthesized using the complicated stabilization techniques to make them less cytotoxic and soluble in water. One of the methods to decrease toxicity and enhance stability of QDs is adsorption on carriers. Here we propose natural aluminosilicate nanotubes as carriers for MChQDs [2, 3].

Methods

We synthesized metal sulfide QDs of various composition stabilized on natural halloysite nanotubes using in-situ synthesis of nanoparticles from nanotube-ligand-metal complexes. First, the clay nanotubes were modified with different ligands such as silanes, azines. Then the metal complexes were formed using nanotubes-ligands and Cd, Cu, Zn salts as metal precursors. Finally, sulfur precursor solutions were added to the system. The materials were characterized using TEM, XRD, and TGA analysis. Fluorescence spectra and diffusion reflectance spectra were obtained. Cytotoxicity was measured.

Results

The formed nanosystems are well structured materials with nanoparticles adsorbed on 0.5-1.0 μm long clay nanotubes with internal diameter from 10 nm to 30 nm. Approximately 50 to 200 nanoparticles were formed on the surface of each nanotube. The particles size distribution was rather monodisperse about 6-9 nm. The systems showed good fluorescent properties as well as good oxidation and photostability, low cytotoxicity. The confocal and enhanced dark-field microscopy images showed the potential of these materials for human cancer cells labeling.

Discussion

The method proposed helps obtaining more than 50 stabilized quantum dots on one single nanotube. Synthesized systems are quiet stable in time and might be use for biological applications due to enhanced stability and decreased cytotoxicity. Good water dispersability of MChQDs stabilized on natural nanotubes important for bioimaging was achieved. The quantum dots may be synthesized at the outer tube's surface or encapsulated inside the clay nanotubes allowing their safe delivery into biocells.

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1. Stavitskaya A., et al. Nanomaterials, 2018, 8, 391-402

2. Lazzara G., et al. Current Opinion Coll. Interface Science, 2018, 35, 42-50

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Topic Area

Quantum dots and colour centres

Session

PS3 » Poster Session (13:30 - Wednesday, 3rd October, HALL & ROOM 3)

Presentation Files

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