Synthesis and characterization of SiO_2 and SnO_2 nanoparticles doped and/or functionalized with rare earth.

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Abstract

In this work, we report the preparation and characterization of SiO_2 and SnO_2 nanoparticles (NPs) doped with rare earth (RE) ions, or anchoring RE-complexes, aiming to generate visible light.

Introduction

Nanoparticles of SiO_2 and SnO_2 find applications in various areas of science, ranging from surface coating agents, transport and controlled release of drugs, optical systems, electro-optical devices[1], etc. A less explored possibility is the use of nanoparticles functionalized with active groups that can anchor molecular luminescent species. Such materials could be applied in biological assays and photodynamic theory due to their properties of biocompatibility and low cytotoxicity, contributing to the development of nanomedicine[2].These materials give rise to a class of compounds called organic-inorganic hybrids with superior properties than the compounds isolated as their precursors. Anchorage of luminescent molecular species such as complexes of RE ions, have been widely described in various studies[3] and attracted great interest to technical, biological and medical applications, e.g. lasers, chemical sensors, catalysis, chromatography, waveguides and biomarkers. Tin dioxide is transparent in the ultraviolet / visible region. It has many applications, for example in transparent electrodes, gas sensors, solar collectors and electro-optical devices. When doped with RE ions, SnO_2 may be used in making devices for optical communication. Because hydroxyl groups are attached to the surface of SnO_2 nanoparticles, they can, in principle, be easily functionalized to anchor RE-complexes. More often studied, SiO_2 nanoparticles offer similar possibilities. The nanoparticles were synthesized and doped and/or incorporated with the luminescent RE species (ions or complexes) by a sol-gel process following the Stober method, and then they were all subjected to photophysical and structural characterization.

Results and Discussion

Samples were conventionally characterized by DRX and MET. Amorphous, undoped nanoparticles of SnO_2, obtained by the sol-gel process presented excitation spectrum and emission red shifted due to he increase of the concentration of the colloidal suspension, indicating a possible increase in the average size of particles causing higher degree of system aggregation. The size control of the NPs is very important for the functionalization of the surface and for the subsequent anchoring of the emitting species. The SiO_2 nanoparticles doped with Eu^{3+} present the characteristic emission peaks of the ion and a progressive increase in the emission intensities with increasing concentration of dopant, indicating good incorporation of the rare earth in the silica matrix. Initial results indicate that subsequent heat treatment of the samples induce increased intensities as well. Based on initial results, we argue that most of the dopant is incorporated into the bulk of SiO_2 nanoparticles and a small amount is on the surface.

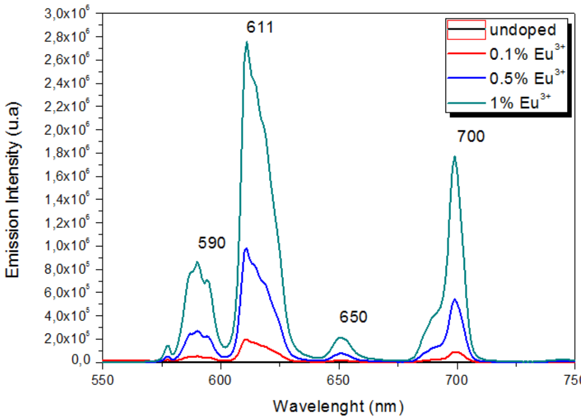

Figure 1. Emission spectrum of SiO_2 nanoparticles doped with Eu^{3+} (0.1, 0.5 and 1.0 %) without heat treatment.

Conclusions

The samples present the conventional characteristic of SiO_2 and SnO_2 NPs. The progressive increase of the emission intensities of the SiO_2:Eu NPs with increasing concentration is due to successful RE incorporation. The SnO_2 NPs present excitation and emission spectra shifted to red depending on the concentration of the colloidal suspension, indicating an increase in nanoparticle size. First results on NPs decorated with active groups are promising and are to be discussed in details.

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