One-dimensional nanostructures of Tellurium as support to preparation of multifunctional materials containing lanthanide ions

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Introduction

At the nanoscale, atoms may be organized in anisotropic crystalline arrangement generating one-dimensional structures (1D) in different ways as wires, rods and tubes[1]. This work was based on the study and preparation of Te nanohelices that were used as templates to preparation of new one-dimensional composites containing lanthanide ions.

Materials and Methods

One-dimensional nanostructures of Te (Te1D) have been prepared by reduction of tellurium oxide (TeO_2) in hypophosphorous acid (H_3PO_2) in aqueous medium, at 60º C, for 24 hours. Te1D nanostructure were afterwards coated with a Resorcinol-Formaldehyde (RF) polymer. Solutions of [$La_{45\%}Ce_{45\%}Tb_{10\%}$] 0.1 mol.$L^{-1}$ and urea 3.3 mol.L^{-1} were added under vigorous stirring. The samples were characterized by Scanning and Transmission Electron Microscopy (SEM and TEM), Raman spectroscopy (RS), and UV/VIS/NIR spectroscopy and Vibrational spectroscopy in the infrared region.

Results and discussion

Te1D structures were obtained from helical endless chains of tellurium atoms. Interconnection of the chains in a hexagonal lattice was mediated by weak Van der Waals interactions, leading for growth of Te1D[2,3]. In Figure 1a, Te1D nanohelices have been obtained. The Te1D nanohelices had diameter in the range of 9-20 nm and lengths below 1 μm. Coating procedures lead to RF coated functional layers (Te@RF) as shown in Figure 1b. The average RF resin shell size of RF ~31 nm. In figure 1c, lanthanide ions were absorbed at the surface in Te@RF nanostructures. The average size of nanoparticles was roughly smaller than 5 nm. Those nanoparticles were homogenously distributed over the whole surface of Te@RF nanocables.

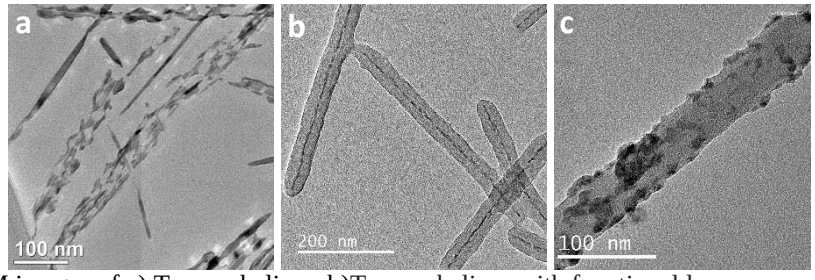

Figure 1. SEM images of a) Te nanohelices, b)Te nanohelices with functional layers around (Te@RF), c) incorporation fo lanthanide ions in Te@RF nanostrucutures.

Absorption spectra in the UV-vis region indicate two characteristic bands of Te1D nanostructures ~ 275 nm and 650 nm, respectively. The Raman spectra show typical bands corresponding to the D_3 symmetry group of the Te lattice with one A_1 mode and two degenerate E modes. After RF coating no important change was observed in optical characteristics.

References

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