Synthesis, characterization and spectroscopic studies of tin/titanium mixed oxide nanoparticles doped with europium for use in biomarkers

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Summary

This work presents a photoluminescence study of nanoparticles based on tin/titanium mixed oxides doped with europium ($SnO_2/TiO_2:Eu^{3+}$), synthesized by co-precipitation method. The nanoparticles were characterized by infrared spectroscopy, thermal analysis, X-ray diffraction, X-ray absorption spectroscopy and luminescent studies. The results showed that these nanoparticles have potential condition to be used by biomarkers.

Keyword

Mixed oxide, tin, titanium and europium

Introduction

Biomarkers have been used for detection of biological species and studies of biological functions. The sensibility is an important factor to theses applications and the rare earth biomarkers supplies this necessity once it allows quickly measured luminescence with high sensibility and accuracy, moreover, they are biocompatible and nontoxic [1].

Quantum dots are nanocrystals semiconductors that open a promising field to develop a new generation of luminescent biomarkers [1]. As fluorescent probes, they have several advantages over conventional organic dyes. Their emission spectra are narrow, symmetrical, and tunable according to their size and material composition, allowing closer spacing of different probes without substantial spectral overlap and they exhibit excellent photostability [2].

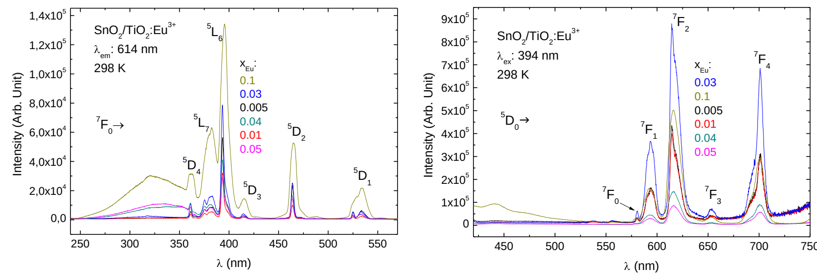
Materials

The luminescent nanoparticles were prepared by neutralization of a mixing solution of tin(+4) chloride, titanium(+3) chloride and europium chloride with ammonia solution, up to pH 7. The particles were aged in the liquor solution for 48 h [3]. The precipitated was washed with water and for analytical control of chloride ions it was made a test with $AgNO_3$. After removal of chloride ions, the material was dried at 383 K. The molar fraction of europium was 0.005, 0.01, 0.03, 0.04, 0.05 and 0.1.

Results and Discussion

The synthesis was effective and the infrared spectra showed a broad band in the region 450 - 700 cm^{-1} was related to the deformation δSn-O-Sn and the stretching νTi-O [4]. The nanoparticles are agglomerates with heterogeneous distribution and homogeneous surfaces that change with the doped increase. The X-ray diffraction showed cassiterite and anatase majority phases and the crystallites size, calculated by Scherrer method, it is ~2 nm. The nanoparticles presented thermal stability with two events of mass losses which were attributed to the dehydration (~358 K) and the crystallization water loss (~543 K) [5]. The TbL_{III} edge XANES data showed one energy band in 6990 eV indicate only trivalent europium [6].

Figure: Excitation and Emission spectra register at 298K.



The excitation spectra showed lines consistent with $^7F_0\rightarrow{}^5L_J$ (J=0–3) Eu^{3+} transitions. It is possible to observe a large band at 300 - 350 nm assigned to O→Sn and O→Eu^{3+} LMCT charge. The bands on 361, 375 and 393 nm correspond at $^7F_0\rightarrow{}^5D_J$, ^5L_J europium ion transitions [7]. The emission spectra were registered with excitation on $^7F_0\rightarrow{}^5L_6$ transition. They showed bands from ^5D_J emission levels. The bands profiles are characteristic of glass matrices doped with lanthanides and the absorption band matrix despair proving that transfer energy process is efficient.

Conclusions

The syntheses were effective and the nanoparticles are agglomerates of thermal stability with cassiterite and anatase phases, nanometric crystallites size and compound by only trivalent europium. The energy transfer from the matrix to europium ion is effective and the 0.03 molar fraction of europium showed better luminescence response.

References

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