

Luminescent magnetic hybrid materials based on europium and terbium complexes

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Luminescent complexes based on lanthanides and β -diketonate ligands may be immobilized on inorganic matrices in order to improve mechanical features, thermal and chemical stability and light-emission properties (e.g., quantum yield, lifetime and UV photostability). Furthermore, materials that combine photoluminescent and magnetic properties could be used in a wide range of applications in biological systems [1] as well as in catalysis [2]. In this regard, we have prepared a hybrid material based on ferrite (Fe_3O_4 , synthesized by co-precipitation method) as support for lanthanides complexes. The material consists of a magnetite core coated by an amorphous silica shell (prepared by sol-gel method) on which europium and terbium complexes are covalently anchored. In a typical sample, dibenzoylmethane (dbm) molecules are covalently anchored on the silica shell of magnetic particle coordinating the europium(III) or terbium(III) ions. To this system, was added the β -diketonate ligand (dibenzoylmethane – dbm, 2-thenoyltrifluoroacetate – tta or 2-(4-methylbenzoyl)indan-1,3-dione – mbind) resulting in the final material. The luminescent samples have been characterized by powder X-ray diffraction (XRD), vibrating sample magnetometry (VSM), thermogravimetric analysis (TGA) and IR absorption spectroscopy (FT-IR) as well as by luminescence spectroscopy. The X-ray diffraction (XRD) patterns of Fe_3O_4 show the characteristic narrow diffraction peaks of magnetite, the relative intensities of which match well with the standard database peaks of the reference pattern (JCPDS file No. 19-0629), confirming the cubic inverse spinel structure of magnetite. The field-dependent magnetic measurements presented nearly zero value of coercivity (H_c) and remanent magnetization (σ_r), suggesting that the materials exhibit superparamagnetic behavior. In the FT-IR spectrum of sample containing tta, the bands $\nu_s(\text{C}=\text{O})$ ($\sim 1600\text{ cm}^{-1}$), $\nu_{\text{ass}}(\text{C}=\text{O})$ ($\sim 1400\text{ cm}^{-1}$) from ligand appears, together with bands of symmetric and asymmetric stretching vibrations of Si–O–Si at $970\text{--}1,088\text{ cm}^{-1}$. The hybrid materials exhibited intense red emission assigned to the 4f-4f transitions of the Eu(III) ion, likewise characteristic green emission of Tb(III), indicating an efficient intramolecular ligand-to-metal energy transfer.

Keywords: Luminescent, Magnetic, Hybrid material, Lanthanides.

Acknowledgements

This work was supported by CNPq and CAPES.

References

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