# Bifunctional optical and magnetic nanocomposites containing $Fe_3O_4$ grafted inorganic matrices and functionalize with $RE^{3+}$ complexes

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The design of bifunctional magnetic luminescent nanomaterials containing $Fe_3O_4$ functionalized with rare earth ion complexes of calixarene and β-diketonate ligands is reported. Their preparation is accessible through a facile onepot method. These novel $Fe_3O_4$@calix-Eu(TTA) (TTA = thenoyltrifluoroacetonate) and $Fe_3O_4$@calix-Tb(ACAC) (ACAC = acetylacetonate) magnetic luminescent nanomaterials show interesting superparamagnetic and photonic properties. Besides, the preparation of bifunctional nanocomposites, co-assembling photonic ($RE^{3+}$) and magnetic ($Fe_3O_4$) features into single entity nanostructures is reported through a facile method, using $Fe_3O_4$ as core nanoparticles, which were coated with $SiO_2$ shell and further grafted with $Eu^{3+}$ and $Tb^{3+}$ complexes. The sophisticated structural features and morphologies of the core-shell $Fe_3O_4$@$SiO_2$-(TTA-RE-L) nanomaterials were studied by SAXS analysis.

The core mean size $\langle D_{SAXS} \rangle$, shell thickness $\Delta R$, cluster size $\xi$ and fractal dimension $D_F$ were determined by fitting the experimental SAXS data, corroborating through Transmission Electron Microscopy images. The DC magnetic properties at temperatures of 2 and 300 K were explored in support to the structural conclusions from SAXS and TEM analyses. The magnetic contributions of the $RE^{3+}$ ions to the magnetizations of the $Eu^{3+}$ and $Tb^{3+}$ nanocomposites were discussed. The photoluminescence properties of the $Eu^{3+}$ and $Tb^{3+}$ nanocomposites based on the emission spectral data and luminescence decay curves were studied (Fig.1). The experimental intensity parameters ($\Omega_\lambda$), lifetimes ($\tau$), emission quantum efficiencies ($\eta$) as well as radiative ($A_{rad}$) and non-radiative ($A_{nrad}$) decay rates were calculated and discussed, in addition, the structural conclusions from the values of the 4f-4f intensity parameters in the case of the $Eu^{3+}$ ion. These novel $Eu^{3+}$ and $Tb^{3+}$ nanocomposites may act as red and green emitting layers for magnetic and light converting molecular devices.

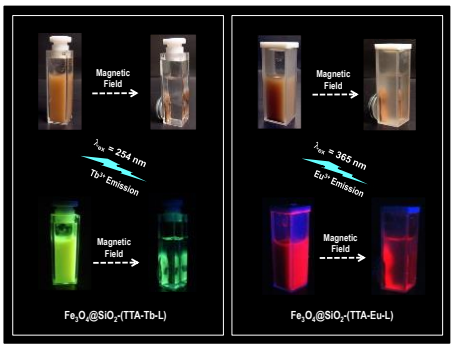


*Fig. 1. Photographs of the $Fe_3O_4$@$SiO_2$-(TTA-RE-L), (RE: Eu and Tb) nanocomposites.*

[1] Khan, L.U.; Brito, H.F.; Hölsä, J.; Pirota, K.R.; Muraca, D.; Felinto, M.C.F.C.; Teotonio, E.E.S.; Malta, O.L. *Inorg. Chem.*, **53** (2014) 2902.
[2] Khan, L.U.; Muraca, D.; Brito, H.F.; Moscoso-Londoño, O.; Felinto, M.C.F.C.; Pirota, K.R.; Teotonio, E.E.S.; Malta. O.L. J Alloys and Compd., 686, 453–466 (2016).

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