Red-emitting magnetic mesocomposites of Ag-decorated Fe_3O_4@SiO_2 nanoflowers coated with Y_2O_3:Eu^{3+}: Study of iron oxide induced luminescence quenching

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The new multistep approach for co-assembling magnetic iron oxide nanoflowers with red-emitting Y_2O_3:Eu^{3+} to form magneto-luminescent mesocomposites was reported. The Fe_3O_4 core particles prepared by solvothermal method were layered with SiO_2 shell and decorated with small size spherical Ag nanoparticles as well as further coated with Y_2O_3:Eu^{3+} lluminophore. The nanoflower shape Fe_3O_4 core of size ~110 nm and crystalline cubic structure of bifunctional iron-oxide@Y_2O_3:Eu^{3+}, Fe_3O_4@SiO_2@Y_2O_3:Eu^{3+} and Fe_3O_4@SiO_2-Ag@Y_2O_3:Eu^{3+} (1 mol%) mesocomposites were confirmed from X-rays diffraction, EDS spectra and transmission electron microscopy images. The static magnetic measurements supported and manifested nonsuperparamagnetic behavior of the materials at 300 K. The iron oxides are usually luminescent quencher, therefore, the photoluminescence properties based on the emission spectral data and luminescence decay curves were studied. In addition, experimental intensity parameters (Ω_λ), lifetimes (τ), emission quantum efficiencies as well as radiative (A_{rad}) and non-radiative (A_{nrad}) decay rates were also calculated, in order to probe the local chemical environment of the Eu^{3+} ion and better understand the phenomena of iron oxide induced luminescence quenching. The highest value of the quantum efficiency = 74 %, for the a-Fe_2O_3@Y_2O_3:Eu^{3+} (1 mol%) among all the luminescent and magnetic mesocomposites suggests that Fe_2O_3 is induced lower luminescence quenching then Fe_3O_4. Though, the thin layer of SiO_2 spacer is caused of increase the quantum efficiency, whereas the Ag is further enhanced the luminescence quenching by energy transfer form Eu^{3+} ion to the Ag nanoparticles. These novel Eu^{3+} mesocomposites may act as a red emitting layer for magnetic and light converting molecular devices.