Synthesis and spectroscopic properties of a new nanostructured red phosphor based in the composite Eu(III)-doped $Y_2(MoO_4)_3$/Au

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Multifunctional materials have been widely investigated in bioanalytical and biomedical sciences because of their potential applications in biosensing, drug delivery, diagnosis, and therapeutics[1]. The $Y_2(MoO_4)_3$:Eu^{3+}/Au composite can combine the luminescence features of $Y_2(MoO_4)_3$:Eu^{3+} and properties of Au providing bifunctionalities in fluorescence imaging with high sensitivity/resolution and high quality molecule detection. The aim of this work was the synthesis, structural and spectroscopic studies of $Y_2(MoO_4)_3$:Eu^{3+}/Au composite that have not been reported yet in the literature. $Y_2(MoO_4)_3$, $Y_2(MoO_4)_3$:Eu^{3+} (2 mol%), $Y_2(MoO_4)_3$:Eu^{3+}/Au (2 mol%) and $Y_2(MoO_4)_3$/Au were synthesized by modified Pechini method and characterized by X-Ray diffraction (XRD), UV-Vis diffuse reflectance (DR) and photoluminescence spectroscopy (PL). XRD data confirmed that all samples have $Y_2(MoO_4)_3$ orthorhombic single phase (JCPDS 28-1451, spatial group P_{bcn}) with high crystallinity. By Scherrer's equation, the average crystallite size values estimated are in the range of 43 to 58 nm and the presence of gold in samples decreases the average crystallite size. From UV-Vis DR spectra, Fig.1(a), samples containing Au exhibit strong absorbance at around 567 nm due to the plasmon resonance of gold, indicating that gold particles are incorporated in the $Y_2(MoO_4)_3$ host[2]. The sharp absorption near 225 nm viewed in all samples spectra is related to the valence band (VB) and conduction band (CB) transitions and corresponds to the bandgap, which value was calculated, being equal 4.19 eV for all samples. The emission spectra of both samples doped with Eu^{3+}, Fig. 1(b), is dominated by the ${}^5D_0 \rightarrow {}^7F_2$ Eu^{3+} hypersensitive transition and a weak ${}^5D_0 \rightarrow {}^7F_1$ one, but the Au presence quenches the red emission. As it shown in diffuse reflectance spectra, gold has an absorption band centered at 566 nm (17668 cm^{-1}). So, there may be a non-radiative energy transfer from the Eu^{3+} ${}^5D_0$ emitter state (17227 cm^{-1}) to the gold's absorption level, quenching the emission of Eu^{3+} ion, which mechanism is represented in Fig. 1(c). So, all results confirm that the synthesis of rare earth molybdates by modified Pechini method was successfully achieved and the gold incorporation quenches Eu^{3+} luminescence; so the produced phosphors exhibit interesting structural and optical features that justify keep exploring their fluorescent applications.

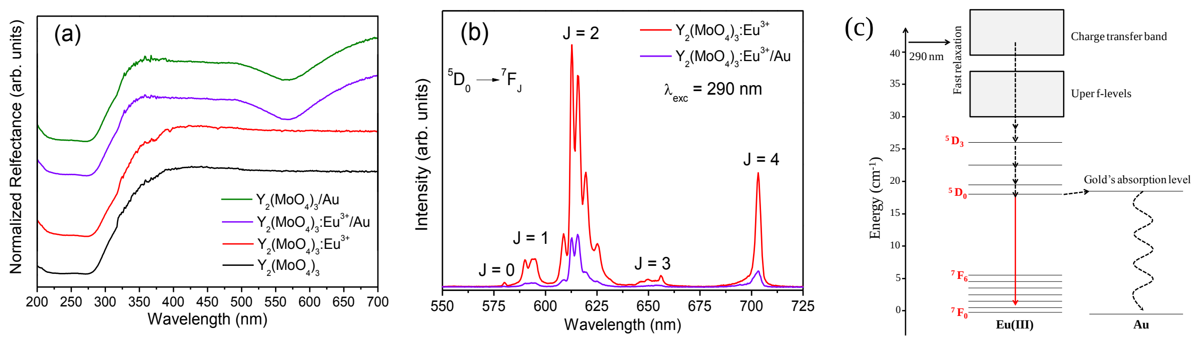

Fig. 1. (a) Diffuse reflectance spectra; (b) Room-temperature emission spectra; (c) Scheme of the possible relaxation and energy transfer models in Eu(III)-doped $Y_2(MoO_4)_3$/Au.

[1]Yang, Y. et al.; *Chem. Phys. Lett.* **2016**, *658*, 259. [2] Pandikumar, A.; Ramaraj, R.; *Mater. Chem. Phys.* **2013**, *141*, 629. [3]Shi, F. N.; Meng, J.; Ren, Y. F.; *J. Solid State Chem.* **1996**, *121*, 236.

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