Influence of the polyalcohol variation in the optical and structural properties of $Y_2O_3:Eu^{3+}$ obtained via modified Pechini method

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$Y_2O_3:Eu^{3+}$ is a well-known red phosphor, where the oxide acts as host matrix, and the rare earth ion as the activator[1]. In search of matrices with suitable features for production of phosphors with enhanced properties, several synthetic routes have been used, such as sol-gel techniques and combustion methods; however, Pechini method has had considerable emphasis because it is a relatively simple route (less equipment needed), inexpensive (polymeric precursors with low price), and fast[2]. The aim of this study was to investigate the influence of polyalcohols: ethylene glycol (EG), glycerol (GL), polyethylene glycol (PEG), and sorbitol (SB) in the optical and structural properties of the $Y_2O_3:Eu^{3+}$ (2 mol%) red phosphor via modified Pechini method, analyzed by X-ray diffraction (XRD), Raman spectroscopy, vibrational spectroscopy, and photoluminescence spectroscopy. Phosphor's XRD data showed that all materials correspond to the Y_2O_3 phase, C-form structure and space group Ia3, without secondary phases regardless of the synthesis conditions, with crystallite size in the range of 24 to 46 nm, whereas the particles produced by using PEG showed the highest mean crystallite size. Raman spectra confirmed the cubic phase of yttrium oxide complementing FTIR data, where Y-O stretching is viewed in the region between 700 and 400 cm^{-1}, with characteristic vibrational modes at 559 and 456 cm^{-1} attributed to the metal-oxygen bond (YO). Emission spectra, Fig. 1, exhibit the Eu^{3+} $^5D_0 \rightarrow {}^7F_J$ set of transitions with maximum intensity at 611 nm, ascribed to the hypersensitive $^5D_0 \rightarrow {}^7F_2$ forced electric dipole transition. All spectra are similar, which indicates that the chemical environment of Eu^{3+} is the same for all samples. However, as it is possible to be viewed in the inset in Fig. 1, the phosphor prepared by glycerol shows the highest relative intensity. Based on these results, it is possible to conclude that complexing agent influences both crystallite size and phosphor relative emission intensity and therefore play an important role in the final optical and structural features of the produced phosphors. Furthermore, the finding that glycerol, low cost reagent and currently by-product in biodiesel production, was the complexing agent that resulted in phosphor with higher relative intensity, opens interesting perspectives for its use in this type of synthesis.

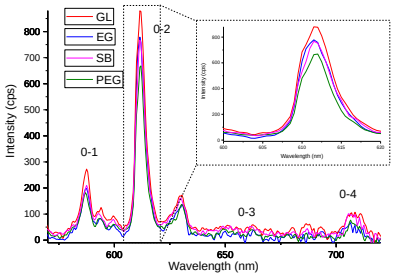

Fig. 1. Emission spectra at room temperature under 250 nm excitation for phosphors prepared using ethylene glycol (EG), glycerol (GL), polyethylene glycol (PEG), and sorbitol (SB).

[1]Ferrari, J.L.; Davolos, M.R.; Pires, A.M.; *Mater. Chem. Phys.* **2009**, *113*, 587.
[2]Petrykin, V., Kakihana, M. Chemistry and applications of polymeric gel precursors. In: Sakka, S., editor. Handbook of sol-gel science and technology: processing, characterization and applications, 2004. p. 77.

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