Influence of preparation methodology on luminescent properties of the nanophosphor Y_2O_3: Er, Yb (2%, 1%)

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Abstract – This work reports on the variation on the methodology preparation of Y_2O_3: Er, Yb (2%, 1%) searching for suitable optical properties to be applied as nano-reporters in immunoassays. Y_2O_3: Er, Yb (2%, 1%) nanophosphor samples were prepared from a polymeric precursor obtained by Pechini´s modified route using ethyleneglycol or sorbitol as polymerizing agents. From spectroscopy investigation it was possible to verity that the phosphor prepared using sorbitol as polymerizing agent shows the higher relative emission intensity. So, this polymerizing agent can be considered advantageous to provide improved nanoparticles to be applied as nanoreporters.

Y_2O_3 or $LiYO_2$ host lattices, when simultaneously doped with erbium and ytterbium ions, show green and red emissions under ultraviolet (UV) or infrared (IR) excitation sources[1]. If IR excitation at 980 nm is used, the infrared quanta near are absorbed by Yb^{3+} ions, and then the energy is transferred to the activator (Er^{3+}) ions in a two-step energy transfer (ET) (up-conversion process). However, when UV source is applied, only Er(III) absorbs and there is no energy transfer between doping ions, so the usual Stokes process takes place[2]. Therefore, the aim of this work is the variation on the methodology preparation of Y_2O_3: Er, Yb (2%, 1%) searching for suitable optical properties to be applied as nano-reporters in immunoassays. Y_2O_3: Er, Yb (2%, 1%) nanophosphor samples were prepared from a polymeric precursor by using a Pechini´s modified route, whereas citric acid is used to provide metallic citrates and ethyleneglycol or sorbitol as polymerizing agents. Table I shows all sample preparation conditions, which were characterized by FTIR and Photoluminescence in the UV-vis.

Table 1. Samples preparation conditions

Sample	Polymerizing agent	Temp and pre-heating time	Temp and pre-heating time	Label
Y_2O_3: Er, Yb (2%, 1%)	EG	750º C/ 4 h	800º C/ 2 h	YOErYb_EG
Y_2O_3: Er, Yb (2%, 1%)	SB	350º C/ 3 hs	750º C/ 2 h	YOErYb_SB

Emission spectra under 380 nm excitation related to $^4I_{15/2} \rightarrow {}^4G_{11/2}$ Er(III) transition show the $^2H_{11/2}$, $^4S_{3/2} \rightarrow {}^4I_{15/2}$ Er^{3+} transitions in the green (520 to 570 nm) and also the red ones $^4F_{9/2} \rightarrow {}^4I_{15/2}$ (640-700 nm), without any changes in energy position or relative intensity, indicating that Er ion is located in the same chemical environment in both samples independent on the synthesis condition. However, YOErYb_SB sample display the higher relative emission intensity. From FTIR analysis, both samples showed similar behavior, whereas the expected M-O vibrational modes were detected below 800 cm^{-1}, as well as typical carbonate group modes between 1800 and 800 cm^{-1}, suggesting that the fine powders, due to high superficial area, must absorb CO_2 from air, or carbonate group could remain as an inclusion impurity during resin calcinations. However, as this impurity was detected in both samples, this fact ensures that luminescent properties are not influence by the presence of carbonate ion. Therefore, the substitution of ethyleneglycol by sorbitol, emphasizing that this sample was obtained under lower time and temperature, can be considered advantageous to provide higher luminescent nanoparticles suitable to be applied as nanoreporters.

References

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