Solid solutions of rare earth oxysulphides for scintillators optimization

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Scintillators are materials that are able to absorb high-energy radiation called ionizing radiation and convert them into lower-energy such as ultraviolet, visible or infrared. Due to this property those materials have many applications such as high-energy physics, industrial inspection, dosimetry and imaging technology for medical diagnosis[1]. Among the different types of scintillators, the trivalent terbium doped gadolinium oxysulphide ($Gd_{2-2x}Tb_{2x}O_2S$) is considered a high-performance one and applied to imaging for radiography and tomography. Being a very applicable material, the optimization of their optical properties becomes a key goal. To analyze the impact of the optimization process, europium doped gadolinium oxysulphide was used because Eu^{3+} has the ability to act as a spectroscopic probe. In order to improve the absorption of X-rays, resulting in the increase of the ionizing radiation conversion efficiency into visible radiation, this work is aimed to replacing a percentage of gadolinium by lutetium and yttrium. Lu^{3+} was chosen for its greater capacity to absorb X-rays due to the large atomic mass and density, while Y^{3+} compensates for the difference between the effective ionic radii of Lu^{3+} and Gd^{3+}, then it makes cheaper lattice. Also, a new synthetic route was proposed to avoid the impurities of carbonate and sulfate detected in the doped gadolinium oxysulphide obtained from rare earth hidroxycarbonate precursor. The results obtained by XRD and FT-IR show the formation of $Gd_{2-2x-2y-2z}Y_{2x}Lu_{2y}Eu_{2z}O_2S$ hexagonal single phase, with low impurities content. UV/Vis photoluminescence spectroscopy (PLS) technique shows the $5D_0 \rightarrow 7F_J$ (J = 0, 1, 2, 3, and 4) transitions from the obtained sample with the same profile from $Gd_{2-2x}Eu_{2x}O_2S$ indicating that the Eu^{3+} occupy the same symmetry sites. Finally, comparing the sample luminescence results from UV/Vis photoluminescence spectroscopy (PLS) with that obtained by x-ray optical luminescence spectroscopy (XEOL), **Figure 1**, it can be pointed out that even the processes involved in the excitation are different there is a good similarity of spectral profiles regarding the Eu^{3+} ion intraconfigurational transitions. Further studies are needed to understand the effect of the Y^{3+} and Lu^{3+} substitution for Gd^{3+} in the material scintillation efficiency.

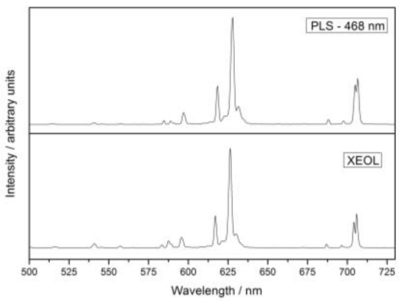

Figure 1 Luminescence of $Gd_{2-2x-2y-2z}Y_{2x}Lu_{2y}Eu_{2z}O_2S$ excited by 468 nm and x-ray radiation

[1]Cebim, M. A.; Oliveira H. H. S.; Barelli, N.; Davolos, M. R. Sistema para realização de medidas de luminescência com excitação por raios X. *Quim. Nova*. 2011, 34, 1057-1062.

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