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SYNTHESIS AND CARACTERIZATION OF BLUE EMITTING NANOSCINTILLATORS

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Introduction: The increasing development of nanodevices in recent decades has potential applications in medical diagnosis and in the treatment of diseases [1]. These nanodevices, when developed with scintillating materials, allow development of new radiation detectors, besides the combination of two therapies widely used for the treatment of cancer, Photodynamic Therapy (PDT) and Radiotherapy (RT), the so-called X-ray activated photodynamic therapy (X-PDT). In this simultaneous treatment, ionizing radiation is used as an energy source and the scintillation nanodevices act as energy mediators, converting the radiation into UV/visible light, in order to sensitize a photosensitizer. These photosensitizers, when activated by a specific wavelength of light, generate reactive oxygen species, which are considered an important toxic agent for tumor cells. While most photosensitizers absorb light in the blue region, few high-efficiency nanoscintilators emit in this spectral region, evidencing the importance of developing blue-emitting nanoscintillators [2,3]. This work aims to develop blue-emitting scintillanting $CaF_2:Eu^{2+}$ and $SrF_2:Eu^{2+}$ nanoparticles for application in X-PDT.

Material and method: $CaF_2:Eu^{2+}$ nanoparticles were prepared by the co-precipitation method. 0.702 mmol of $CaCl_2$ $2H_2O$ and $17.56x10^{-3}$ mmol of $EuCl_2$ were dissolved in 18 ml of anhydrous ethanol. Then 0.06 mmol of cetyl trimethylammonium bromide (CTAB) was added. 1.405 mmol of NH_4F was slowly added after the solution had been stirred for 15 min at 40 °C. The mixture was stirred for 12 h. The precursors were separated by centrifugation and washed with ethanol 4 times. Finally, the obtained solution was dried at 100 °C and then calcined at 600 °C for 30, 60 and 180 min in air, in order to observe an increase in the reduction of Eu^{3+} to Eu^{2+}.

Results: The luminescent properties of the powder sample were investigated by radioluminescence. Figure 1 shows the emission spectrum of $CaF_2:Eu^{2+}$ with 3 different calcination times. The intense emission of Eu^{2+} at 425 nm can be attributed to the transition $4f^65d^1 \rightarrow 4f^7$. The emission at 590 nm, 615 nm and 690 nm indicates the presence of Eu^{3+}, originating from the transitions from $^5D^0$ to $^7F^1$, $^7F^2$ and $^7F^3$, respectively. The presence of Eu^{3+} probably occurs due to a partial oxidation of Eu^{2+} during synthesis and/or calcination. The decrease in the intensity of Eu^{3+} emission indicates that the longer the annealing, the greater the reduction from Eu^{3+} to Eu^{2+}.

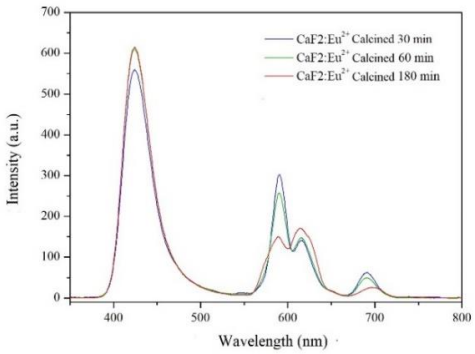

Figure 1: Radioluminescence spectra of CaF2:Eu2+ with 3 different annealing times.

Conclusions: The $CaF_2:Eu^{2+}$ nanoparticles showed emission in the region of interest. The next step is the morphological and structural characterization by scanning and transmission electron microscopy techniques, dynamic light scattering, zeta potential and X-ray diffraction.

References:

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