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Annealing temperature effect on the optical and photoluminescent properties of $Sr_{0.97}Eu_{0.03}MoO_4$ powders

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Abstract – $Sr_{0.97}Eu_{0.03}MoO_4$ (SEMO) powders were prepared in this work using the Complex Polymerization Method, and were heat treated from 400 to 900°C for 2 hours. X-ray Diffraction (XRD) and Photoluminescent Measurements show only a crystalline scheelite-type phase for these materials and the emission spectra of the samples presented bands related to the Eu^{3+} $^5D_1 \rightarrow {}^7F_0$; $^5D_1 \rightarrow {}^7F_2$; $^5D_0 \rightarrow {}^7F_0$; $^5D_0 \rightarrow {}^7F_2$; $^5D_0 \rightarrow {}^7F_3$ and $^5D_0 \rightarrow {}^7F_4$ transitions. The lifetime of the Eu^{3+} $^5D_0 \rightarrow {}^7F_2$ transition was evaluated as around 0.60 ms.

$SrMoO_4$ doped with rare earth have been studied nowadays and due to their applications as scintillating materials in electro-optical like solid-state lasers and optical fibers[1] have attracted great attention. RE laser hosts such as double molybdates are the aim of researches due to the large absorption cross sections of RE ions in their lattice.[2-3] In this work, $Sr_{0.97}Eu_{0.03}MoO_4$ powders were synthesized by the Complex Polymerization Method and were heat treated from 400 to 900°C for 2 hours. The structural and optical properties of the $SrMoO_4:Eu^{3+}$ powders were characterized by powder X-ray Diffraction (XRD), Fourrier Transform Infrared (FTIR), Raman Spectroscopy and Photoluminescent Measurements. XRD patterns (Figure 1) show only a crystalline scheelite phase characterized by the 112 peak at 2θ = 27,8º. The excitation spectra of $SrMoO_4:Eu^{3+}$ were obtained setting the emission at 614 nm, and presented the characteristic excitation band of Eu^{3+} $^5L_6$ transition at 394 nm as well as a broad one at around 288 nm ascribed to charge transfer from O^{2-} to Eu^{3+} in the $SrMoO_4$ matrix. All the emission spectra (Figure 2) of the $SrMoO_4:Eu^{3+}$ excited at 394 nm presented the characteristic emission bands related to the $^5D_1 \rightarrow {}^7F_0$, $^5D_1 \rightarrow {}^7F_1$ and $^5D_1 \rightarrow {}^7F_2$ transitions at, respectively, 523, 533 and 554 nm, besides the Eu^{3+} $^5D_0 \rightarrow {}^7F_{0,1,2,3 \text{ and } 4}$ ones at around 578, 589, 614, 652 and 699 nm, respectively. When the samples were excited at 288 nm it was also observed the same behavior. The band referent to the $^5D_0 \rightarrow {}^7F_0$ transition indicates the presence of Eu^{3+} site without inversion center. This hypothesis is strengthened by the fact that the band referent to the $^5D_0 \rightarrow {}^7F_2$ transition is the most intense in the emission spectra. The lifetime of the Eu^{3+} $^5D_0 \rightarrow {}^7F_2$ transition was evaluated as around 0.60 ms. It can be concluded that the Complex Polymerization Method is one viable technique for synthesize doped materials presenting only the "scheelite" phase. The study of the temperature effect from 500 to 900°C on the $Sr_{0.97}Eu_{0.03}MoO_4$ (SEMO) powders was performed because this sample presents the highest emission intensity among the 1.0 and 5.0 % samples. The optical properties observed for $SrMoO_4:Eu^{3+}$ powders suggest that the Eu^{3+}doped $SrMoO_4$ with could be considered as a promising red phosphor for LEDs application.

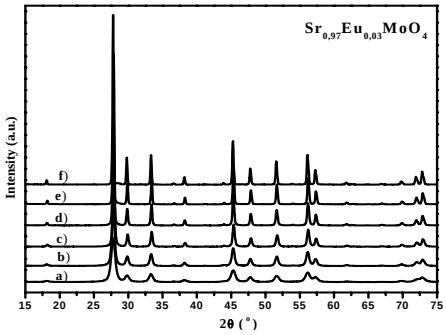

Figure 1: X-ray diffraction patterns of $Sr_{0.97}Eu_{0.03}MoO_4$ heat-treated at 400 (a), 500 (b), 600 (c), 700 (d), 800 (e) and 900°C (f) for 2h.

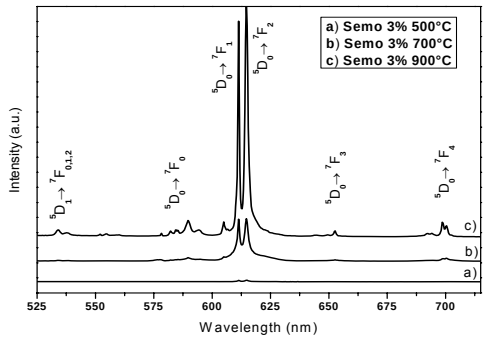

Figure 2: Room-temperature emission spectra of the $Sr_{0.97}Eu_{0.03}MoO_4$ powders. Heat treated at 500, 700 and 900°C for 2 hours.

References
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