Synthesis of crystalline Nd:YVO_4 nanoparticles obtained by the non-hydrolytic Sol-Gel process.

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Introduction

Neodymium-doped yttrium orthovanadate Nd:YVO_4 is a very powerful solid-state laser material. Nd^{3+} ions in this material present a broad and strong absorption band around 808 nm and a very intense emission in the 1 µm range, presenting many applications in the fields of military, industry, medical treatment and scientific research. Compared with a conventional Nd:YAG crystal, Nd:YVO_4 offers many advantages such as a broader absorption bandwidth, a larger effective stimulated emission cross-section, and a higher allowed doping level [1]. Among the various methodologies, the non-hydrolytic sol-gel process stands out as one of the most advantageous: it yields highly pure products (the metallic oxides originate in situ) with fewer pores; occurs at relatively low temperatures; provides strict control of stoichiometry, powder morphology, and phase purity; cations are distributed all over the polymeric structure; and is easier to reproduce [2]. This work reports the synthesis, characterization and photoluminescence properties of $Y_{(x)}Nd_{(0.01)}VO_4$, where x = 0.99 and 0.49% mol) obtained by the non-hydrolytic Sol-Gel route and annealed at 800 and 1000 °C during 4h. The samples were characterized by X-ray diffraction and photoluminescence.

Results e Discussion

Fig. 1 show the X-ray diffraction patterns of the samples annealed at 800 and 1000 °C. It can be seen that the heat treatment temperature does not significantly alter the crystal structure of YVO_4, presenting peaks that can be indexed to the tetragonal structure YVO_4 (JCPDS # 16-250). However, the $Y_{(0.99)}Nd_{(0.01)}VO_4$ and $Y_{(0.49)}Nd_{(0.01)}VO_4$ samples presented peaks that could be indexed to the cubic structure of Y_2O_3 (JCPDS # 41-1105) and the orthorhombic structure of V_2O_5 (JCPDS # 41-1426), respectively.

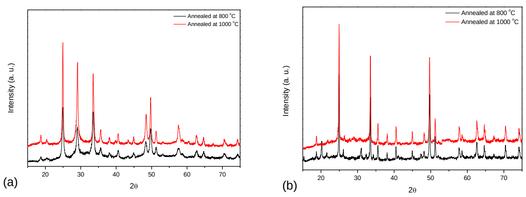

Figure 1. X-ray diffraction patterns for the samples: a) $Y_{(0.99)}Nd_{(0.01)}VO_4$ and b) $Y_{(0.49)}Nd_{(0.01)}VO_4$ annealed at different temperatures.

Figures 2 and 3 show the excitation and emission spectra of Nd^{3+} ions in the $Y_{(0.99)}Nd_{(0.01)}VO_4$ and $Y_{(0.49)}Nd_{(0.01)}VO_4$ samples annealed at different temperatures. From the excitation spectra, it can be observed for all samples bands between 500 and 900 nm assigned to the Nd^{3+} transitions. In addition, a broadband around 310 nm was observed and is related to the charge transfer (CTB) from the V^{5+} – O^{2-} the VO_4^{3-} group [3]. However, relative intensity of the CTB was higher for the $Y_{(0.49)}Nd_{(0.01)}VO_4$ sample.

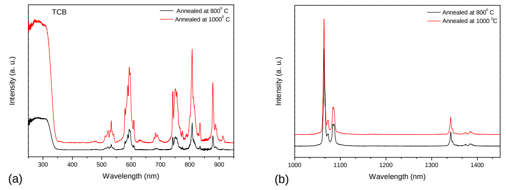

Figure 2: $Y_{(0.99)}Nd_{(0.01)}VO_4$ luminescence spectr recorded at room temperature: a) excitation spectrum (λ_{em}: 1076 nm) and b) emission spectrum (λ_{exc}: 310 nm).

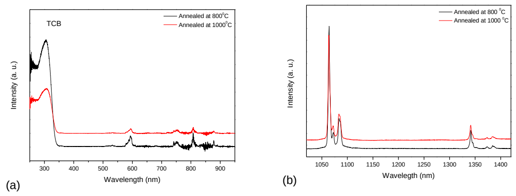

Figure 3: $Y_{(0.49)}Nd_{(0.01)}VO_4$ luminescence spectr recorded at room temperature: a) excitation spectrum (λ_{em}: 1076 nm) and b) emission spectrum (λ_{exc}: 310 nm).

For the emission spectrum, there are two major bands, one at about 1076 nm attributed to the transition $^4F_{3/2}$ – $^4I_{11/2}$ and the other at 1344 nm attributed to the transition $^4F_{3/2}$ – $^4I_{13/2}$ of Nd^{3+} ion.

Conclusion

Nd:YVO_4 nanoparticles were prepared by the non-hydrolytic Sol-Gel process and from the results obtained, it was observed that the concentration of the Y^{3+} ions can directly influences on the crystalline structure of the material and the luminescent properties.

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