Study of conditional parameters on the luminescent properties of Nb_2O_5:La^{3+},Tm^{3+} materials obtained by the non-hydrolytic Sol-Gel process.

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Introduction

Currently, solid-state white light emitters (LEDs) are considered the next generation of solid-state light sources. Bearing in mind that illumination consumes about 33% of all the generated energy, the development of energy-saving systems has become fundamental from a technological standpoint [1]. Ultraviolet (UV) radiation provides high excitation energy, so a new strategy to obtain white light relies on the use of near UV radiation by LEDs coated with blue/green/red luminophores. Because the luminescence properties of rare earth ions are sensitive to the chemical environment, the choice of host is crucial.

In this sense, niobium oxide doped with La^{3+} has emerged as a promising material for multifunctional applications. Its band gap is around 4.8 eV; it has a relatively low cut-off phonon energy of 900 cm^{-1} and a high refractive index; it emits blue and UV light when excited with UV and X-ray radiation, respectively. Among the various methodologies that are available to synthesize luminophores, the non-hydrolytic sol-gel process stands out as one of the most advantageous: it yields highly pure products with fewer pores; occurs at relatively low temperatures and is easier to reproduce [3]. Here, we report the study of Tm^{3+} concentration (1 and 3% mol/mol) in the Nb_2O_5:La matrix prepared by the non-hydrolytic Sol-Gel route and annealed at 550 and 900°C during 4h. The samples were characterized by X-ray diffraction and photoluminescence.

Results and Discussion

The X-ray diffractograms of the samples annealed at 550 °C present peaks that can be indexed to the orthorhombic phases of the Nb_2O_5 (JCPDS # 30-873) and Nb_3O_7Cl (JCPDS # 73-295). The material annealed at 900°C also showed two distinct phase formed by the monoclinic structure of Nb_2O_5 (JCPDS # 15-166) and by the orthorhombic structure of $La_2Nb_{10}O_{28}$ (JCPDS # 20-547). However, increasing thulium concentration favors the onset of cubic phase indexed to the Tm_2O_3 (JCPDS # 76-160). Figures 1 and 2 show the excitation and emission spectra of Tm^{3+} ions in the samples annealed at different temperatures. From excitation spectra, it can be noted that the sample annealed at 900°C presented two broad bands at approximately 260 nm and 395 nm referring to the charge transfer matrix. The transition $^1D_2 \rightarrow {}^3H_4$ (Tm^{3+}) was observing in the emission spectra only for samples annealed at 900°C. This is related to the crystalline structure of the matrix in which the Tm^{3+} ions are embedding, since higher processing temperatures provide more crystalline systems.

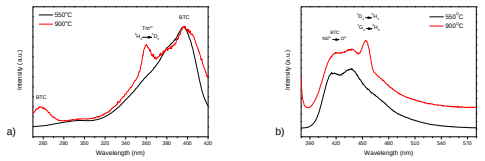

Figure 1. a) Excitation spectrum (λ_{em}: 454 nm) and b) emission spectrum (λ_{exc}: 360 nm).

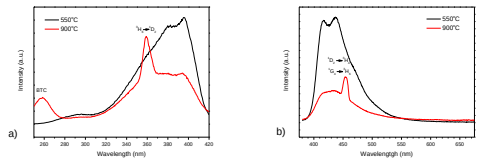

Figure 2. a) Excitation spectrum (λ_{em}: 454 nm) and b) emissiion spectrum (λ_{exc}: 360 nm).

Conclusion

Nb_2O_5:La^{3+},Tm^{3+} luminescent materials were prepared by the non-hydrolytic Sol-Gel process. From the results obtained, it was observed that the heat treatment temperature and the concentration of the Tm^{3+} ions can directly influence on the crystalline structure of the material and the luminescent properties.

Acknowledgement

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