Synthesis and characterization of crystalline Er,Yb:Nb_2O_5 by the non-hydrolytic Sol-Gel route.

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Introduction

Over the years, many different types of materials have been synthesized to fulfill the growing demand in the telecommunications segment. In this context, different Er^{3+}-doped materials have been developed for photonic applications, especially for use as optical amplifiers operating around 1.5 µm, which corresponds to the C telecommunication band. The addition of a co-doping sensitizer was adopted in order to enhance the near-infrared luminescence intensity significantly while maintaining relatively low Er^{3+} concentrations. In this sense, the preparation of Er^{3+}/Yb^{3+} co-coped materials can markedly increase the absorption at 980 nm this is because the Yb^{3+} ions have higher absorption cross-section, which culminates in a more efficient pumping mechanism and consequently enhances the Er^{3+} emission around 1550 nm. Because the luminescence properties of rare earth ions are sensitive to the chemical environment, the choice of host is crucial. In this context, the Nb_2O_5 is transparent over a wide range of wavelengths, it has a relatively low cut-off phonon energy of 900 cm^{-1} and a high refractive index. In addition, Nb_2O_5 is a polymorphic material that can contain different crystalline phases, depending on the preparation method and annealing temperature, which can directly affect the luminescent properties [1]. Here, we report the study of Er^{3+}/Yb^{3+} concentration in the Nb_2O_5 matrix prepared by the non-hydrolytic Sol-Gel route and annealed at 900 °C during 4h. The samples were characterized by X-ray diffraction and photoluminescence.

Results e Discussion

Fig. 1 show the X-ray diffractograms of the samples annealed at 900 °C. Both samples present peaks indexed to the Nb_2O_5 monoclinic structure (JCPDS # 19-862 and 37-1468). However, increasing the ytterbium concentration favors the onset of phase indexed to the JCPDS # 19-862 and the monoclinic structure of YbNbO4 (JCPDS # 23-1480).

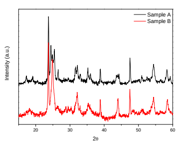

Fig. 1. X-ray diffractograms of the (Er^{3+}/Yb^{3+})-doped samples at different concentrations: (A) 1:4 and b) 1:8.

Fig. 2 shows the excitation and emission spectra for the Er^{3+}/Yb^{3+} co-doped samples.

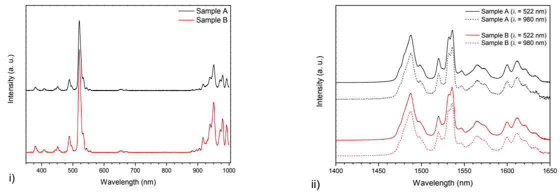

Fig. 2. Excitation (λ_{em}: 1535 nm) and emission (λ_{exc}: 522 and 980 nm) spectra for the Er^{3+}/Yb^{3+} co-doped samples: (a) 1:4 and b) 1:8.

In Fig. 2(i), the excitation spectra show bands assigned to the erbium transitions wherein the most intense band at 522 nm is assigned to the $^4I_{15/2} \rightarrow {}^2H_{11/2}$ transition. The luminescence is centered in two main bands at around 1488 and 1536 nm. In addition, the emission falls into the transmission window of optical fibers. Ytterbium ions act as sensitizers and absorb the 980 nm light by exciting the ions from the $^2F_{7/2}$ ground state to the $^2F_{5/2}$ excited state. The energy is then transferred to the $^4I_{11/2}$ excited state of the erbium ions, from where it non-radiatively decays to the $^4I_{13/2}$ excited state. The luminescence shown in Fig. 2(ii) results from the transition of the $^4I_{13/2}$ excited state to the $^4I_{15/2}$ ground state [2].

Conclusion

The results show that the sol-gel route can produce Er,Yb:Nb_2O_5 nanoparticles. Moreover, increasing the ytterbium concentration favors the structural change of the Nb_2O_5 phase. The Optical measurements confirmed the characteristic near-infrared.

Acknowledgements

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[1] F. T. Aquino et al., Materials Chemistry and Physics xxx (2014) 1-10.

[2] H. Eilers, Materials Letters 60 (2006) 214–217.