OPTICAL PROPERTIES OF Ho^{3+}-Yb^{3+} AND Nd^{3+} DOPED SiO_2-LaF_3 GLASS-CERAMICS BY SOL-GEL METHOD

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At present time, rare earth ions doped oxyfluoride glass-ceramics have a great interest in the development of optical devices as lasers, optical amplifiers and upconverters. These materials have the spectroscopic advantages of the fluoride hosts, due to their low phonon energies, and the good mechanical and chemical properties of the oxide glasses. Moreover, they remain transparent due to the nanoscale of the fluoride crystals [1].

The upconversion and near-infrared emissions of Ho^{3+} ions have been investigated in oxyfluoride glass-ceramics obtained by conventional melting method [2]. Upconversion emissions have been also obtained in Ho^{3+}-Yb^{3+} co-doped oxyfluoride glass-ceramics prepared by sol-gel method [3]. On the other hand, infrared emission at 1.06 μm of Nd^{3+} ions is one of the most widely studied infrared emissions for lasers devices. However, there are only few works related the lasers properties of Nd^{3+} in glass-ceramics [4].

In this work, the optical properties of rare earth doped SiO_2-LaF_3 oxyfluoride glass-ceramics prepared by sol-gel method are studied, focusing attention on UV and VIS up-conversion emissions for Ho^{3+}-Yb^{3+} co-doped samples and near infrared emission for Nd^{3+}-doped samples.

Oxyfluoride glass-ceramics with composition $5LaF_3$-$95SiO_2$ codoped with 0.1 Ho^{3+}-0.3 Yb^{3+} (mol%) or doped with 0.1 Nd^{3+} (mol%) were prepared by sol-gel method in a similar way as Fujihara et al.[5]. Nanocrystals of LaF_3 were precipitated by heat-treatment and identified by X-ray Diffraction. In previous work we used sol-gel technique for the preparation of silica based transparent glass-ceramics doped with Eu^{3+} ions [6].

The optical spectra indicate that a fraction of the Ho^{3+} ions are incorporated to the LaF_3 nanocrystals. As a consequence, efficient UV and VIS upconversion emissions are observed under direct infrared excitation of the Yb^{3+} ions at 980 nm (see Fig.1). The upconversion mechanisms were investigated: UV emission is obtained by a three-photon process whereas only two photons are necessary to obtain the VIS emission. On the other hand, for the Nd^{3+}, the stimulated emission cross-section has been calculated using the F-L equation based on the spontaneous emission spectrum (see Fig. 2). The absorption cross-section has been derived from emission spectrum on the basis of reciprocity method of McCumber. As a result, gain cross-section wavelength dependence has been computed, as a function of population inversion of involved states.

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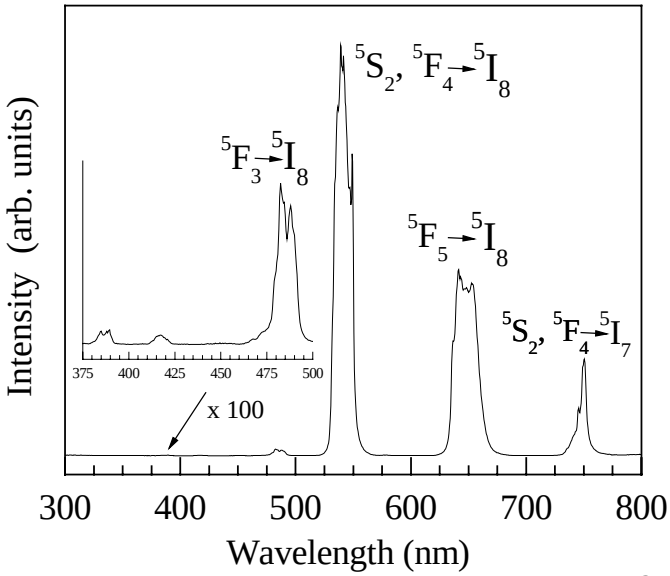

Fig 1. Up-conversion emission spectrum of $95SiO_2$-$5LaF_3$: $0.1Ho^{3+}$- $0.3Yb^{3+}$ (mol%) glass-ceramics obtained under 980 nm excitation at room temperature (inset: magnified spectrum in the wavelength range of 375 - 500 nm).

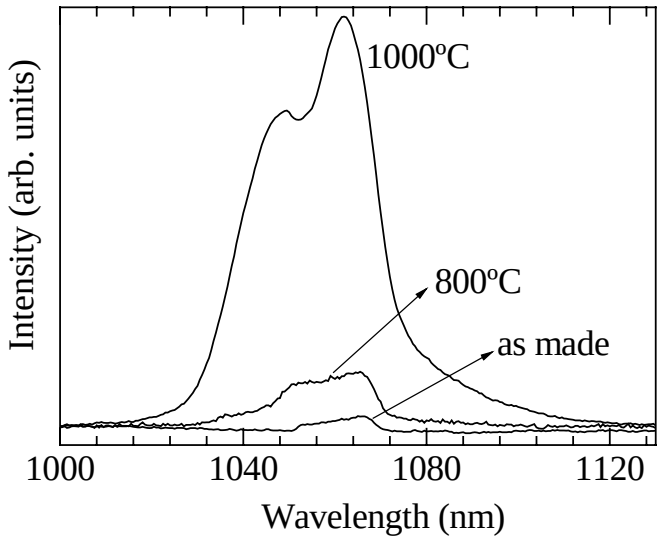

Fig 2. Emission spectra of $95SiO_2$-$5LaF_3$ doped with 0.1mol% of Nd^{3+} samples, as made and heat treated at 800 and 1000ºC respectively, exciting at 800 nm.