STRUCTURE AND UP-CONVERSION LUMINESCENCE IN TRANSPARENT Er^{3+}-Yb^{3+} Co-Doped SiO_2-PbF_2 SOL-GEL DERIVED NANO-GLASS-CERAMICS

J. del-Castillo[a], A.C. Yanes[a], J. Méndez-Ramos[b], J.J. Velázquez[b]
V.K. Tikhomirov[c] and V.D. Rodríguez[b]

[a] Departamento de Física Básica
[b] Departamento de Física Fundamental y Experimental, Electrónica y Sistemas
Universidad de La Laguna, La Laguna, Tenerife, Spain
[c]INPAC- Institute for Nanoscale Physics and Chemistry, Katholieke Universiteit Leuven, Belgium

josvel@ull.es

Rare-earth doped materials have been extensively investigated due to their potential applications in photonic devices, such as laser and optical amplifiers [1, 2]. In particular, rare-earth doped oxyfluoride glass-ceramics have attracted much attention because they combine the low phonon energy environment of fluoride crystal with the chemical, mechanical and thermal stability of oxide glasses [3]. Different results in these glass-ceramics containing PbF_2 nanocrystals can be found in the literature [4,5]. In order to avoid technical difficulties of conventional melting techniques, sol-gel method can be used to prepare high purity glasses, with ease in the composition and homogeneity control and lower processing temperature [6].

In the present work, Er^{3+}-Yb^{3+} co-doped silica based transparent glass-ceramics containing PbF_2 nanocrystals were successfully obtained by adequate thermal treatments of sol-gel precursor glasses with composition $90SiO_2$-$10PbF_2$ codoped with 0.3 Yb^{3+} and 0.1 Er^{3+} (mol %). The structural analysis by XRD and TEM has shown the precipitation of cubic β-PbF_2 nanocrystals with radii between 5-10 nm, calculated by using Scherrer's equation. Up-conversion luminescence pumped at 980 nm has been observed and studied, some spectra are shown in Fig. 1. Up-conversion emission bands show well-resolved Stark components confirming the incorporation of the rare-earth ions into precipitated nanocrystals. Colour tuneability of up-conversion luminescence by varying pump power has been analyzed in terms of standard chromaticity diagram. This tuneability opens the way to applications for up-conversion phosphors and three-dimensional optical recording.

References:

[1] D.J. Norris, A.L. Efros and S.C. Erwin, Science **319** (2008) 1776; V. I. Klimov, Nature **447** (2007) 441.
[2] V.D. Rodríguez, V.K. Tikhomirov, J. Méndez-Ramos and A.B. Seddon, Europhys. Lett. **69** (2005) 128.
[3] Y.H. Wang and J. Ohwaki, Appl. Phys. Lett. **63** (1993) 3268.
[4] M. Mortier, A. Bensalah, G. Dantelle, G. Patriarche, D. Vivien, Opt. Mater. **29** (2007) 1263.
[5] Zhongchao Duan, Junjie Zhang, Weidong Xiang, Hongtao Sun, Lili Hu, Mater. Lett. **61** (2007) 2200.
[6] J. del-Castillo, V.D. Rodríguez, A.C. Yanes, J. Méndez-Ramos and M.E. Torres, Nanotechnology **16** (2005) 300.

Figures:

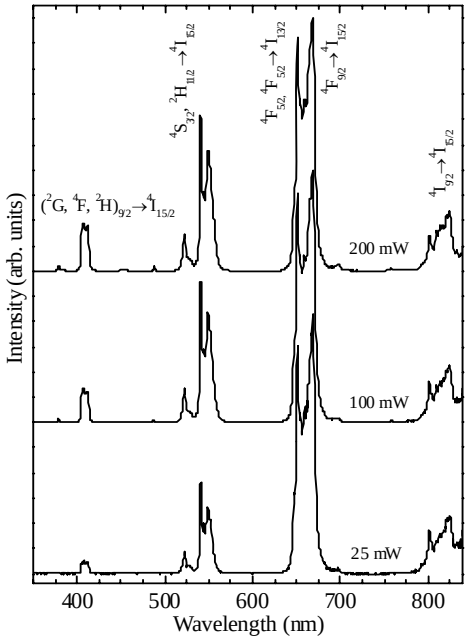

Fig. 1. Up-conversion emission spectra under 980 nm excitation, at indicated pump powers, normalized to the maximum at 660 nm.