# COLOR TUNEABILITY AND WHITE LIGHT GENERATION IN $Yb^{3+}$-$Ho^{3+}$-$Tm^{3+}$ DOPED $SiO_2$-$LaF_3$ NANO-GLASS-CERAMICS PREPARED BY SOL-GEL METHOD

**J.J. Velázquez[1*], A.C. Yanes[2*], J. del-Castillo[2], J. Méndez-Ramos[1] and V.D. Rodríguez[1]**

[1]Departamento Física Fundamental y Experimental, Electrónica y Sistemas

[2]Departamento Física Básica

Universidad de La Laguna, 38206 La Laguna, Tenerife, Spain

*josvel@ull.es* *ayanesh@ull.es*

There is a great interest in the tuneability of the infrared-to-visible up-conversion phosphor for general lighting appliances and integrated optical devices [1]. In this sense, rare-earth doped oxyfluoride nano-glass-ceramics (GCs) appear as ideal luminescent materials for active optical devices, combining spectroscopic advantages of the fluoride hosts, due to their low phonon energies, and the good mechanical and chemical properties of the oxide glasses [2,3]. Special attention has been paid to sol-gel derived nano-glass-ceramics, since the sol-gel process is an alternative synthesis method without the difficulties of conventional melt-quenching techniques [4,5]. In particular, $LaF_3$ is an excellent fluoride host material due to high solubility for rare-earth ions and very low phonon energy (300-400 $cm^{-1}$), reducing non-radiative loss by multiphonon relaxation [6].

In this work, we report a transparent nanostructured glass-ceramics with composition $95SiO_2$-$5LaF_3$ co-doped with 0.3 $Yb^{3+}$, 0.1 $Tm^{3+}$ and 0.1 $Ho^{3+}$ (mol%) synthesized by thermal treatment at 800 ºC of precursor sol-gel derived glasses prepared in a similar way as Fujihara et al. [4]. Precipitation of $LaF_3$ nanocrystals, with an estimated size of 9 nm, during ceramming process was confirmed by X-ray diffraction and TEM and HRTEM analysis. Simultaneous efficient up-conversion luminescence comprising of blue, green and red emission bands under infrared excitation at 980 nm was observed, like shown in Fig. 1. Color tuneability and white light generation has been achieved varying the ratio between up-conversion emission bands by changing pump power of infrared excitation as indicated in the CIE diagram in Fig. 2. This leads the way for applications in 3-D colour optical recording/displays, white light generation for ambient lighting and biological labels [7].

References:

[1] C.Feldmann, T.Justel, C. R. Ronda and P. J. Schmidt, Adv. Func Mater. 13, (2003), 511.

[2] Y.H. Wang and J. Ohwaki, Appl. Phys. Letters **63**, (1993), 3628.

[3] J. Méndez-Ramos, V.K. Tikhomirov, V.D. Rodríguez and D. Furniss, J. Alloys Compd. **440**, (2007), 328.

[4] S. Fujihara, C. Mochizuki and T. Kimura, J. Non Crist. Solids **244**, (1999), 267.

[5] J. del-Castillo, V. D. Rodríguez, A. C. Yanes, J. Méndez-Ramos and M. E. Torres, Nanotech. **16**, (2005), 300.

[6] J.J. Velázquez, A.C.Yanes, J. del-Castillo, J. Méndez-Ramos and V.D. Rodríguez, *Physica Status Solidi (a)* **204**, (2007), 1762.

[7] J. del-Castillo, J. Méndez-Ramos, A. C. Yanes and V. D. Rodríguez, J. Nanopart. Res. in press, (2008).

**Figures:**

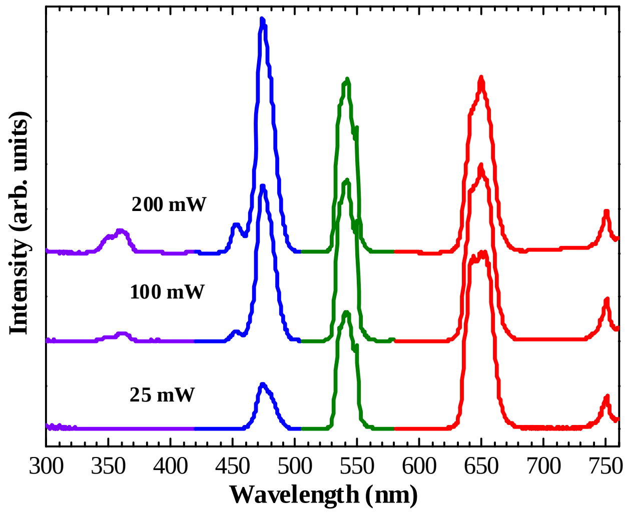


**Fig. 1.** Simultaneous up-conversion emission spectra under infrared excitation at 980 nm at 25, 100 and 200 mW pump power of $95SiO_2$-$5LaF_3$ doped with 0.3 $Yb^{3+}$, 0.1 $Ho^{3+}$ and 0.1 $Tm^{3+}$ (mol%) nano-glass-ceramics heat treated at 800 ºC. Spectra have been normalized to the maximum of the 660 nm red emission.

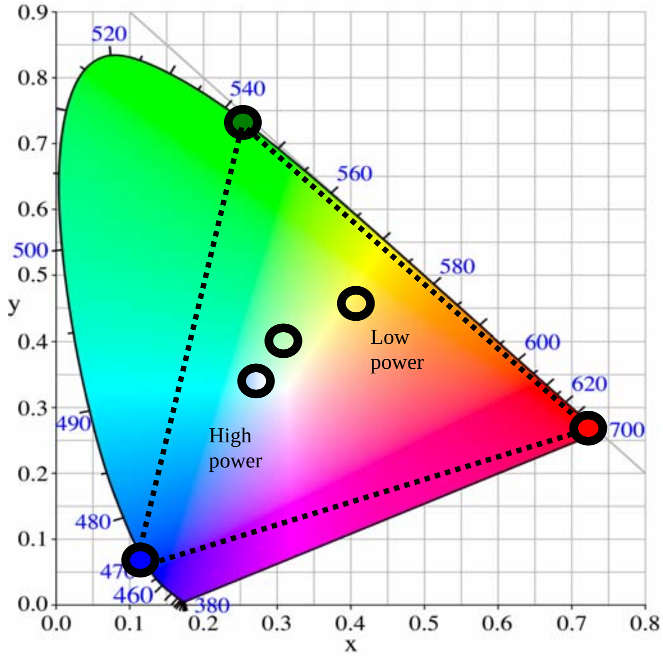


**Fig. 2.** Comission Internationale d'Eclairage (CIE) coordinates of $95SiO_2$-$5LaF_3$ doped with 0.3 $Yb^{3+}$, 0.1 $Ho^{3+}$ and 0.1 $Tm^{3+}$ (mol%) nano-glass-ceramic under excitation at 980 nm from high (200 mW) to low pump power (25 mW). Internal dotted triangle shows the wide colour gamut covered by the emission of sample.