Pure red upconverted and NIR luminescence properties of Er^{3+}-doped SnO_2 nanocrystalline powders

V. Kalaivani[1], P.V. Rajeswari[2], S. Kaleemulla[3], R. Praveena[2*], N. Vijaya[4]

[1]Sri Venkateswara College of Engineering & Technology (A), Chittoor – 517 127, India.
[2] Gayatri Vidya Parishad College of Engineering (A), Visakhapatnam – 530 048, India.
[3]Centre for functional materials, Vellore Institute of Technology, Vellore – 632 014, India.
[4]S.V. University, Tirupati – 517 502, India.
*Corresponding author email Id: praveena@gvpce.ac.in

Abstract

Tin oxide (SnO_2) nanocrystalline powders doped with Er^{3+} ions in different molar ratios (0, 3, 5 and 7 mol%) were prepared by solid state reaction method. These powders were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), ultraviolet-visible absorption and visible upconversion and near infrared luminescence techniques. XRD analysis revealed tetragonal rutile structure of SnO_2 in all the samples with an average crystallite size of about 32 nm. From the Tauc's plots it was confirmed that incorporation of Er^{3+} ions into the SnO_2 host lattice and resulted in narrowing its band gap. Absorption bands at 525 and 658 nm correspond to the 4f electron transitions of Er^{3+} ions further confirm the visible light absorption. Infrared luminescence spectra showed a broad band cantered at 1534 nm which is attributed to the $^4I_{13/2} \rightarrow {}^4I_{15/2}$ transition of Er^{3+} ion (Fig. 1) [1]. The visible upconverted luminescence spectra under the excitation wavelength of 980 nm exhibit a strong red luminescence with a main peak at 664 nm which is assigned to the $^4F_{9/2} \rightarrow {}^4I_{15/2}$ transition of Er^{3+} ion and confirming that two photons were involved in the upconversion mechanism (Fig. 2) [2]. The intensity of both visible and infrared luminescence increases with increasing Er^{3+} ion concentration even up to 7 mol%. The results pave the way for the potential applications of these nanocrystalline powders in energy harvesting applications such as infrared light upconverting layer in solar cells, light emitting diodes, NIR broadband sources and amplifiers and biological labelling.

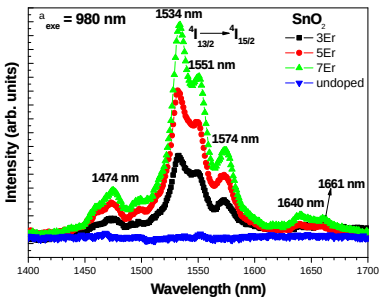

Fig. 1. NIR emission spectra of Er^{3+}:SnO_2.

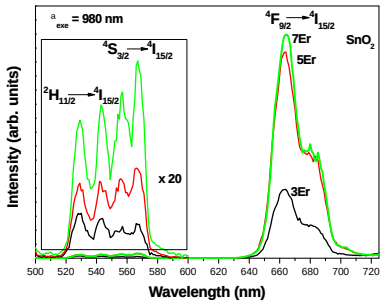

Fig. 2. Upconversion spectra of Er^{3+}:SnO_2.

Acknowledgement: *This work was supported by Gayatri Vidya Parishad College of Engineering (A), Visakhaptnam, India.*

References

[1] X. Wang, X. Kong, Y. Yu, Y. Sun, H. Zhang, J. Phys. Chem. C 111 (2007) 15119-15124. doi.org/10.1021/jp0686689.
[2] S. Tabanli, G. Bilir, G. Eryurek, J. Lumin. 182 (2017) 146-153. doi.org/10.1016/j.jlumin.2016.10.009.