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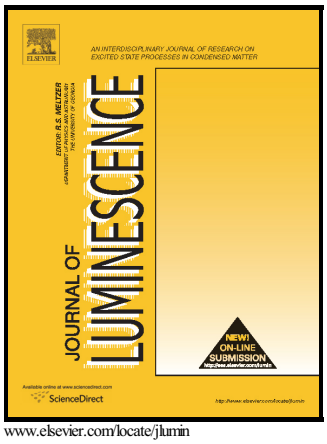

www.elsevier.com/locate/jlumin

PII: S0022-2313(15)00335-X
DOI: http://dx.doi.org/10.1016/j.jlumin.2015.06.017
Reference: LUMIN13412

To appear in: *Journal of Luminescence*

Received date: 12 February 2015
Revised date: 10 June 2015
Accepted date: 12 June 2015

Cite this article as: M. Lluscà, J. López-Vidrier, S. Lauzurica, M.I. Sánchez-Aniorte, A. Antony, C. Molpeceres, S. Hernández, B. Garrido and J. Bertomeu, Activation of visible up-conversion luminescence in transparen and conducting ZnO:Er:Yb films by laser annealing, *Journal of Luminescence,* http://dx.doi.org/10.1016/j.jlumin.2015.06.017

Activation of visible up-conversion luminescence in transparent and conducting ZnO:Er:Yb films by laser annealing

M. Lluscà[a,*], J. López-Vidrier[b], S. Lauzurica[c], M. I. Sánchez-Aniorte[c], A. Antony[a,d], C. Molpeceres[c], S. Hernández[b], B. Garrido[b] and J. Bertomeu[a]

[a] *Department of Applied Physics and Optics, Universitat de Barcelona, Barcelona 08028, Spain*

[b] *Department of Electronics, Universitat de Barcelona, Barcelona 08028, Spain*

[c] *Centro Laser, Universidad Politécnica de Madrid, Madrid 28031, Spain*

[d] *Indian Institute of Technology Bombay, Mumbai 400076, India*

*E-mail: marta.llusca@ub.edu; Tel: +34 9340 39223

1. Introduction

Most thin film solar cells are not able to absorb photons with energy lower than its band gap and this is very much applicable for photons in the near infrared wavelength. One way to enhance low energy photon absorption could be to convert these photons into higher energy ones by using rare earth (RE) ions such as Er and Yb. Rare earth materials have been widely studied due to their photoluminescence properties, which occur as a result of their intra 4*f*-4*f* shell transitions [1]. In particular, Er and Yb co-doped systems [2-4] have the capability to cooperate together to convert infrared radiation into visible light because of their energy levels matching for $\lambda = 980$ nm [5]. Yb species act as the absorber ions due to their higher absorption coefficient, thus absorbing the incoming low-energy photons (980 nm), whereas Er species act as the emitter ions, releasing higher-energy photons (550 nm, 660 nm, etc.) (see Fig. 1). In this work, ZnO has been chosen as the host matrix for Er and Yb ions with the intention to create a transparent and conducting up-converting material that will function as the transparent conducting oxide (TCO) back contact as well as to, exploit the up-conversion mechanism to enhance the efficiency of the solar cells.