Persistent luminescence mechanisms of Pr^{3+}-, Eu^{3+}-, Tb^{3+}-doped lutetium oxide

C. C. S. Pedroso[1,*], J. M. Carvalho[2], L. C. V. Rodrigues[1], J. Hölsä[3], H. F. Brito[1]

[1] *University of São Paulo, Institute of Chemistry, BR-05508-000, São Paulo-SP, Brazil.* [2] *University of São Paulo, Institute of Physics, Department of Applied Physics, BR-05508-090, São Paulo-SP, Brazil.*
[3] *University of the Free State, Department of Physics, Bloemfontein ZA-9300, South Africa.*
* *Corresponding author: ccsp@iq.usp.br*

Persistent luminescence is a phenomenon where the material emits radiation from seconds to several hours after cessation of irradiation, such as light, UV radiation, electrons, etc. Persistent luminescence, a special case of thermally stimulated luminescence, results from storage of the excitation energy in traps and its subsequent release induced by thermal energy available at the appropriate temperature [1,2]. The persistent luminescence mechanisms are not entirely agreed upon for every material, however. In this work, the $Lu_2O_3:R^{3+},M$ (R,M: Pr,Hf^{IV}; Eu,Ca^{2+} or Tb,Ca^{2+}) materials were prepared. Persistent luminescence spectra of the materials show red/NIR, reddish orange and green emission assigned to the $4f^N \rightarrow 4f^N$ transitions characteristic of Pr^{3+}, Eu^{3+} and Tb^{3+} ions, respectively. Inclusion of Hf^{IV} and Ca^{2+} co-dopants in the Lu_2O_3 host increases the emission intensity and duration of persistent luminescence due to generation of traps caused by charge compensation in the lattice as well as these ions in the Lu^{3+} sites. The persistent luminescence mechanisms were developed through similar principles based on experimental data of band gap energy, energy level position of $R^{2+/3+}$ ions in the host and trap energies as shown for $Lu_2O_3:Tb^{3+},Ca^{2+}$ (Fig.). This similarity confirms the correct interpretation of the experimental data for the $Lu_2O_3:R^{3+},M$ materials and encourages the expansion of similar models for other persistent luminescence materials.

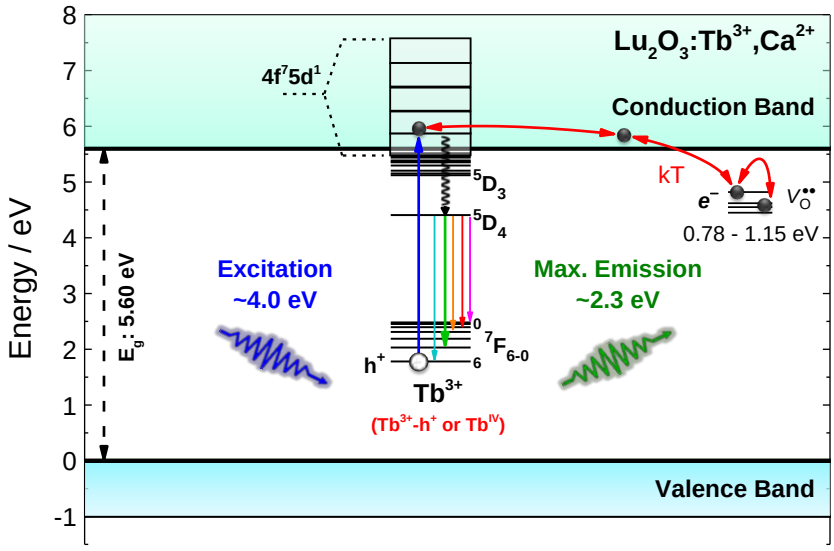

Figure: Persistent luminescence mechanism of $Lu_2O_3:Tb^{3+},Ca^{2+}$.

Keywords: Persistent luminescence mechanisms, Praseodymium, Europium, Terbium, Lutetium oxide.

Acknowledgements

The authors acknowledge CNPq, CAPES and FAPESP (Brazil) for financial support as well as LNLS (Brazil) for the synchrotron measurements.

References

[1] K. van den Eeckhout, D. Poelman, P. F. Smet, Materials 6 (2013) 2789–2818.
[2] C. C. S. Pedroso, J. M. Carvalho, L. C. V. Rodrigues, J. Hölsä, H. F. Brito, ACS Appl. Mater. Interfaces 8 (2016) 19593–19604.

18th International Conference on Luminescence – ICL 2017, from August 27th to September 1st 2017, João Pessoa, Paraíba, Brazil.