Trapping in persistent phosphors

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Persistent phosphors or glow-in-the-dark materials are luminescent materials with the ability to emit light for minutes up to hours after the excitation has ended. Although they are currently used in various established and emerging applications, the origin of the energy storage mechanism is still largely unknown [1,2]. Up to now, there are still several competing models on the energy storage mechanism in these phosphors, with respect to the energetic position and the nature of the trap levels. We now report on both facets of the energy storage. First of all, the depth and shape of trap level distribution can be estimated by performing a series of thermoluminescence experiments with varying excitation duration and at varying excitation temperature, in combination with the initial rise analysis method. It is shown that the traps responsible for the energy storage in the blue-emitting $CaAl_2O_4$:Eu,Nd are not discrete, but rather have a Gaussian-like broadened distribution (with trap depth centered around 0.9eV) [3]. Secondly, a possible valence state change of the rare earth co-dopants in $SrAl_2O_4$:Eu,RE is evaluated by combined optical excitation and x-ray absorption studies [4]. Based on both types of observations, the presently available models are critically evaluated.

[1] K. Van den Eeckhout, P.F. Smet, D. Poelman, Materials 3, 2536 (2010)

[2] K. Van den Eeckhout, D. Poelman, P.F. Smet, Materials 6, 2789 (2013)

[3] K. Van den Eeckhout, A.J.J. Bos, D. Poelman, P.F. Smet, Phys. Rev. B 87, 045126 (2013)

[4] K. Korthout, K. Van den Eeckhout, J. Botterman, S. Nikitenko, D. Poelman, P.F. Smet, Phys. Rev. B 84, 085140 (2011)