Tailoring the Properties of Rare Earth Activated Oxide Scintillators by Bandgap Engineering

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Scintillation light yield, i.e. the number of photons emitted by the studied material following the absorption of an unit of energy (1 MeV) delivered by ionizing radiation, seems to be one of the most important parameters used to rate and compare scintillators. Models have been proposed to predict theoretical limits for particular compounds and there are various scintillators that indeed display light yields close to such estimations [1]; the well-known $LaBr_3$:Ce is one of the examples. On the other hand, many materials are characterized by scintillation yields much lower than it could be expected.

An interesting case is provided by $Lu_3Al_5O_{12}$:Pr (LuAG:Pr). First it was observed that its somewhat disappointing room temperature scintillation yield could be enhanced significantly by increasing temperature to 400-450 K. Soon afterwards, this behavior was attributed to the existence of shallow electron traps and their temperature-dependent contribution to the scintillation mechanism, more precisely to the trap-mediated route of the energy transfer between the LuAG host and the Pr^{3+} ions. Furthermore, an active role of traps was demonstrated by a novel experiment combining X-ray and laser excitation [2]. The magnitude of the trap related scintillation yield loss in LuAG:Pr was estimated as about 30-40%.

In this Tutorial Lecture the most important methods that have successfully been introduced to reduce the unfavorable influence of traps on the light yield of selected oxide scintillators will be reviewed. Attention will be focused on the approach known as "bandgap engineering", nevertheless some other concepts will also be discussed.

[1] Dorenbos P. (2002) NIM, A486, 208-213.
[2] Drozdowski W., Dorenbos P., Drozdowska R., Bos A.A.J., Poolton N.R.J., Tonelli M., Alshourbagy M. (2009) IEEE TNS, 56, 320-327.

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