TEMPERATURE-DEPENDENT STUDY OF CATHODOLUMINESCENCE INTENSITY AND DECAY OF CERIUM-ACTIVATED YAG SINGLE CRYSTALS

O. Lalinsky[1,*], J. Bok[1], P. Schauer[1]

[1] *Institute of Scientific Instruments of the ASCR, v.v.i., Kralovopolska 147, 612 64 Brno, Czech Republic*
* Corresponding author: xodr@isibrno.cz

Highlights

Cathodoluminescence parameters of Ce-activated YAG single crystals with different concentration of cerium at different temperatures

Abstract

Yttrium aluminium garnet (YAG) $Y_3Al_5O_{12}$ is a crystalline material of the garnet group. Ce-activated YAG (YAG:Ce) gains very useful properties in comparison to the Ce-free one, and therefore YAG:Ce is used for example as a phosphor in white light-emitting diodes or as a scintillator material [1]. 35 years ago, Robbins *et al.* published series of successful papers studying cathodoluminescence (CL) properties of rare-earth activated YAG crystals [2,3]. Their previous work has been successful and often cited till now, because there is no so complex work dedicated to CL study of YAG:Ce. However, as Robbins *et al.* admit, their results are distorted by some inadvertent impurities in the initial material for YAG:Ce single crystal growth. Unlike that time, nowadays there are more advanced technologies of YAG:Ce single crystal growth, which focus on material purity and defect-free crystal structure of the garnet. Meanwhile, there have been improved ways how to study CL properties to reach significantly better results, such as higher spectral and time resolution or higher dynamic range of a detector. This induces a requirement to revise and improve studies of Robbins *et al*.

Specimens of the YAG:Ce single crystal with different concentration of Ce-activator (including Ce-free) have been studied using a unique CL apparatus in our laboratory [4]. CL spectra were measured (Fig. 1) for the YAG:Ce single crystal with cerium concentration of 0.22 mol%. Moreover, in comparison to studies of Robbins *et al.*, the spectra were corrected for system response. Therefore, the luminescence band caused by the defect centres (near UV) has higher reliability than the previous studies of Robbins *et al*. Referring to the Fig. 1, it can be observed, that the mentioned luminescence band produces a shift to longer wavelengths with increasing temperature. Moreover, CL intensity decay characteristics were obtained at different temperatures and at different wavelengths having a much higher dynamic range against former studies of Robbins *et al*. The nature of CL centres was explained using the thermally stimulated luminescence. Results were analysed and then interpreted by a more sophisticated physical model leading to a better understanding of energy transition processes in YAG:Ce.

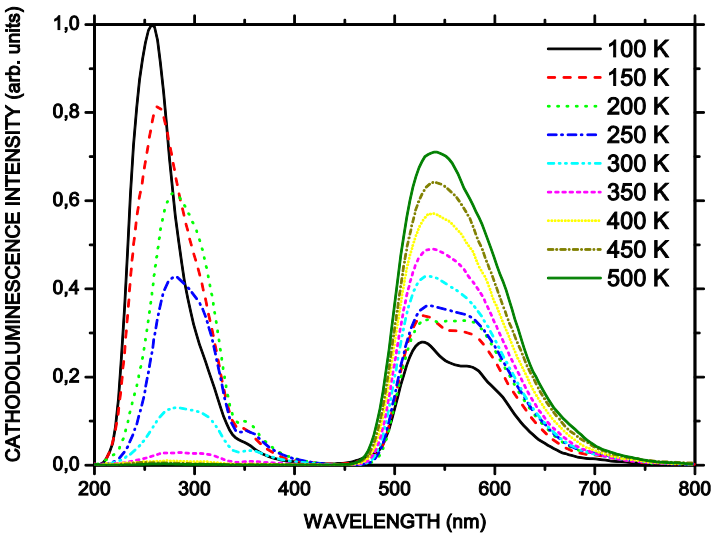

Figure 1. Cathodoluminescence spectra of YAG:Ce (0.22 mol%) single crystal at different temperatures. Spectra were corrected for system response.

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