Time-resolved luminescence study of rare-earth doped garnet scintillators

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Single crystals of lutetium-aluminium garnet $Lu_3Al_5O_{12}$ (LuAG) doped with trivalent rare-earth ions (e.g., Ce^{3+}, Pr^{3+}) have high density, an intense and fast emission and high mechanical and chemical stability [1-4]. Owing to these characteristics, these crystals have been considered as promising scintillator materials for X-ray and γ-radiation detectors to use them in nuclear spectroscopy, high energy physics, chemistry, medical imaging, security systems etc. Depending on specific purposes the scintillators should satisfy many requirements, most common of them are high light yield, fast response, high density, and chemical and radiation stability. Some of applications, such as medical imaging (especially time-of-light PET-tomography) make a critical demand to dynamic properties in terms of extremely short rise and decay time.

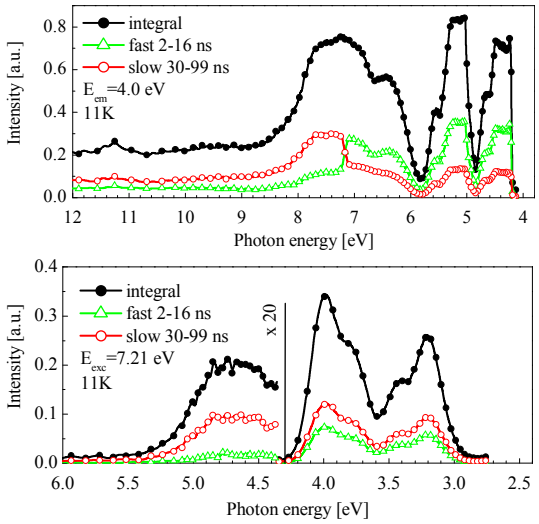

Figure 1: Excitation (a) and emission (b) spectra of LuAG :Pr crystal.

In the emission spectrum, the main Pr^{3+}-related emission bands are located in the range 4.0-3.2 eV. Relative intensities of the ultraviolet Pr^{3+}-related emission bands depend strongly on the excitation energy. The UV emission bands are excited in the band-to-band absorption region as well as in the exciton band around 7 eV. Additional high-energy excitation bands are located at lower energies around 6.9-6.2 eV. The Pr^{3+}-related excitation bands are located around 5.2 eV and 4.3 eV (Fig. 1).

In present communication, the energy- and time-resolved spectroscopic investigations will be reviewed and summarized for Pr^{3+}-doped garnet single crystals in wide spectral and temperature ranges [5]. The results will be compared with those obtained also for the undoped and Ce^{3+}-doped crystals. The nature of luminescence centres and energy transfer processes will be discussed.

References

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