Optical and photoelectrical properties of Ce^{3+} and Mg^{2+}-Si^{4+} co-doped $Gd_3Ga_5O_{12}$ and $Gd_3Ga_3Al_2O_{12}$ single crystalline films

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In this work, we present the results of crystallization and investigation of the optical and photoelectrical properties singly Ce^{3+}, doubly Ce^{3} -Mg^{2+}, and triply Ce^{3+}-Mg^{2+}-Si^{4+} doped of $Gd_3Ga_5O_{12}$ and $Gd_3Ga_3Al_2O_{12}$ single crystalline films (SCF). These garnets possess a relatively low band gap E_g =6.2-6.4 eV compared to well-known YAG and LuAG garnets with Eg =7.8-8 eV and can be suitable for the creation of photo-sensitive e/h trapping levels in the case of Mg^{2+}-Si^{4+} donor-acceptor doping.

The SCF samples were grown by the liquid phase epitaxy (LPE) method onto $Gd_3Ga_5O_{12}$ (GGG) and $Gd_3Ga_{2.5}Al_{2.5}O_{12}$ (GAGG) substrates, respectively, from the melt–solution based on the PbO-B_2O_3 flux. The absorption, luminescence, and photoelectrical properties of Ce^{3+} doped and Mg^{2+}-Si^{4+} codoped SCFs of GGG and GAGG garnets were investigated using conventional spectral methods and compared with the properties of the reference GGG:Ce and GAGG:Ce crystal and ceramic samples. In addition, the influence of the thermal annealing at 1300 ^{o}C in air and in 95% N_2 - 5% H_2 reducing atmosphere on the optical and photoelectrical properties of both types of SCFs was investigated.

Moreover, the luminescent properties of selected SCF samples were studied at 10 K under excitation by synchrotron radiation (SR) with energy in the 3.5-12.0 eV range at P66 Superlumi station at PETRA 3 storage range at DESY, Germany. Based on these results, the energy structure of different Ce^{3+} related centers in Mg^{2+}-Si^{4+} codoped SCF samples were compared with respect to the band structure of these garnets.

The results of this complex study are helpful for the development of luminescent materials for composite photovoltaic screens as well as for the creation of the composite thermoluminescent and optically-stimulated detectors based on the epitaxial structures of Ce^{3+} doped and Mg^{2+}-Si^{4+} codoped garnets, producing by LPE growth method.

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