

Nanooptics and photonics

Green-emitting $\text{Gd}_3\text{Ga}_5\text{O}_{12}:\text{Tb}^{3+}$ nanoparticles phosphor: synthesis, structure and luminescence

A. Luchechko^{1*}, L. Kostyk¹, S. Varvarenko², O. Tsvetkova¹, O. Kravets¹

¹ Faculty of Electronics, Ivan Franko National University of Lviv, Tarnavskogo St. 107, 79017 Lviv, Ukraine.

E-mail: luchechko@electronics.lnu.edu.ua

² Department of Organic Chemistry, National University "Lvivska Politehnika", Bandera St. 12, 79013 Lviv, Ukraine.

Rare-earth doped gadolinium gallium garnet ($\text{Gd}_3\text{Ga}_5\text{O}_{12}$, GGG) has attracted much attention as an important material for application in many optical devices. At the same time, nanostructure materials are also considered to be potentially useful for technological application in optoelectronics, biomedicine and other areas of science and technology, because such materials show new, often enhanced properties compared to the bulk crystals [1].

Nanoparticles of GGG doped with 1 mol. % Tb^{3+} were synthesized via the chemical co-precipitation method using polyethylene glycol as the precipitating agent. The obtained GGG: Tb phosphors were characterized by X-ray powder diffraction (XRD), scanning electron microscope (SEM), atomic force microscopy (AFM), photoluminescence excitation (PLE) and PL emission spectra.

The GGG nanopowders start to crystallize at 800 °C and the crystallite size increases with the annealing temperature. XRD patterns showed that all synthesized nanoparticles have a pure cubic garnet structure without the presence of another phases. Scanning electron microscopy images demonstrate that nanoparticles are in the range of 25-40 nm.

Characteristic strong lines assigned to the $^5\text{D}_4 \rightarrow ^7\text{F}_j$ ($j = 6, 5, 4, 3$) transitions of the Tb^{3+} ions are observed in the emission spectra of GGG: 1mol.% Tb^{3+} nanoparticles under the UV excitation. Dominant green emission of Tb^{3+} ions at 545 nm corresponding to $^5\text{D}_4 \rightarrow ^7\text{F}_5$ transition is represented for all nanoparticles.

The influence of the the particle size to the shape of the Tb^{3+} emission was analyzed. The luminescence intensity of the samples prepared in polyethylene glycol is higher than in other mixed solvents. Excellent luminescence characteristics make GGG: Tb^{3+} nanopowders as a potential green phosphor.

I. L. Kostyk, A. Luchechko, S. Varvarenko, B. Pavluk, O. Tsvetkova
Preparation and luminescence properties of $\text{Gd}_3\text{Ga}_5\text{O}_{12}$ nanocrystalline garnet// Chem. Met. Alloys.-2011.-4.-77-80.