Nanoscale physics

Impact of spinel $MgAl_2O_4$: Sm nanoparticles size on optical spectra

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Luminescence and excitation spectra of different size nanoparticles with spinel structure $MgAl_2O_4$ doped by Sm^{3+} ions were studied. Nanoparticles were synthesized by a co-precipitation technique using $Al(NO_3)_3 \cdot 6H_2O$ and Mg(NO3)2·6H2O salts. The amounts of Sm^{3+} ions were 0, 0.03, 0.3 and 3 weight percent. Implantation of Sm^{3+} ions into the $MgAl_2O_4$ during the synthesis gives a possibility to determine structural changes of the samples. The implanted Sm^{3+} acts as a probe. Indeed, optical and luminescence spectra are the most sensitive to structural deformation of the nearest environment of rare-earth ions, to the formation of vacancies in the first coordination sphere, and to a ligand composition changes. To use Sm^{3+} ions as a probe of spinel $MgAl_2O_4$ samples we have applied the Modified Crystal Field Theory (MCFT) [1]. This method allows us to calculate an electronic spectrum of the Sm^{3+}, which is placed in a crystal matrix of an arbitrary symmetry and shape [2].

It is shown that the nanoparticles with different sizes reveal different concentration threshold of luminescence quenching and different splitting of the spectral bands. This can be due to two factors caused by the difference in the ionic radii of the regular and impurity ions: 1. segregation of Sm^{3+} ions near the surface of nanoparticles, 2. distortion of the local structure of impurity centers.

1. *Gornostaeva, O. V., Lamonova K. V., Orel S. M., Pashkevich Yu. G.* Magnetic properties of Ce^{3+} ion in iron containing oxypnictide CeFeAsO // *Low Temp. Phys. – 2013 – **39**. – P. 343–350.*

2. *Babkin R. Yu., Gornostaeva O. V., Lamonova K. V., Orel S. M., Prudnikov A. M., Pashkevich Yu. G., Viagin O. G., Maksimchuk P. O., Malyukin Yu. V.* Formation mechanism of luminescence spectra of carbon nitride films doped by europium chloride CN_x : $EuCl_3$ // Journal of Luminescence – 2017 – **186 –** P. 247 – 254.