

Nanoscale physics

Luminescence spectrum of the carbon-nitride films doped by the europium ions

R. Yu. Babkin¹, O. G. Vyagin², O. V. Gornostaeva³, P. Maksimchuk², A. M. Prudnikov¹

¹*O. O. Galkin Donetsk Institute for Physics and Engineering, National Academy of Sciences of Ukraine, Nauky av., 46, Kyiv-03039, Ukraine
E-mail: r.yu.babkin@gmail.com*

²*Institute for Single Crystals, National Academy of Sciences of Ukraine, Nauky av., 60, Kharkiv-61001, Ukraine*

³*G. V. Kurdyumov Institute for Metal Physics, National Academy of Sciences of Ukraine, Academician Vernadskyi blvd., 36, Kyiv-03680, Ukraine*

This work represents the complex experimental and theoretical study of the luminescence spectra of the nano-structural magnetron-sputtered carbon-nitride films CN_x with the Eu^{3+} ions as a probe. As the rare-earth target the $EuCl_3$ is applied. The films were formed under different conditions (power, cathode current, substrate temperature etc.) and with the different europium ions concentrations.

The carbon-nitride films with a dopant concentration of 4.5 at.% and 10 at.% exhibit the luminescence spectra like $EuCl_3$ one with frequency shift, which depend on the initial rare-earth dopant concentration. The simulations of the luminescence spectra were carried out by the modified crystal field theory (MCFT-method) [1]. Theoretical calculations and comparisons with the reference $EuCl_3$ substance are showed that the most of the $[EuCl_9]^{6-}$ -complexes in films are involved in chemical bonds with carbon-nitride matrix CN_x . The additional splitting of the electron levels, as well as changes in the intensities of the spectral lines could be connected to the low-symmetry distortion of the $[EuCl_9]^{6-}$ -coordination complex and indicates a loss of translational and local symmetry of the $EuCl_3$ nanoparticles. It was found that some of $[EuCl_9]^{6-}$ complexes have defects such as vacancies, but the overall proportion of the complexes with vacancies is minimal and can be well identified only in films with a high europium concentration.

1. K. V. Lamonova, E. S. Zhitlukhina, R. Yu. Babkin, S. M. Orel, S. G. Ovchinnikov, Yu. G. Pashkevich. Intermediate-spin state of a 3d ion in the octahedral environment and generalization of the Tanabe-Sugano diagrams // J. Phys. Chem. A. 2011. 115, № 46. P. 13596-13604.