Electronic excitations in $LuPO_4$-Eu and $LuPO_4$-Pr nanoparticles

V. Vistovskyy, T. Malyy, A. Voloshinovskii, A.Getkin[1], O. Shapoval[2], A. Zaichenko[2], N. Mitina[2]

Ivan Franko National University, Kyryla i Mefodiya st., 8, Lviv, 79005, Ukraine
[1]Institute for Scintillation Materials, NAS Ukraine, Kharkiv, Ukraine
[2]National University "Lvivska politekhnica", Lviv, Ukraine

Introduction

One of the directions for a new scintillation material creation is connected with using of unique physical properties of nanoparticles embedded in crystal, polymeric or glass matrix. Besides the technological problems of the transparent nanocomposite fabrication there is also the problem of elucidation of luminescence intensity dependence of nanoparticles on their size and energy of exciting quanta. In the present work we studied the confinement effect influence for luminescence of $LuPO_4$-Eu and $LuPO_4$-Pr nanoparticles upon high energy excitation, caused by presence of the electron and hole recombination mechanisms of luminescence upon band to band transitions in these systems.

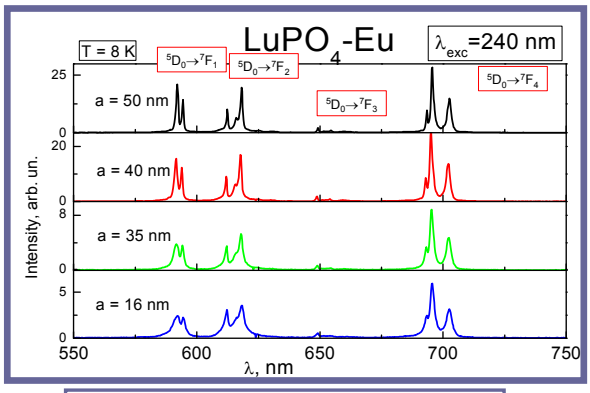

Fig.1 Luminescence spectra of $LuPO_4$-Eu

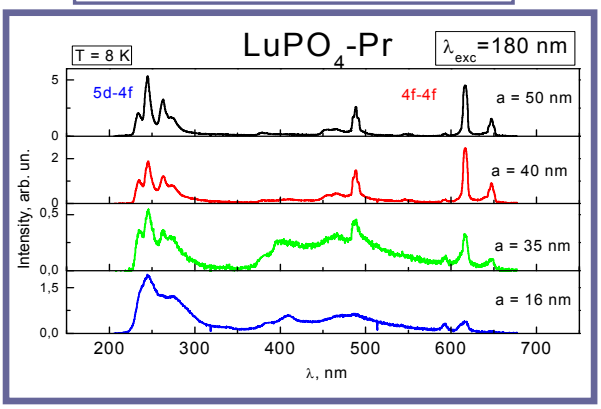

Fig.2 Luminescence spectra of $LuPO_4$-Pr

Experiment

$LuPO_4$-Eu and $LuPO_4$-Pr nanoparticles have been synthesized by the template micelle method using the surfactants. The nanoparticle size was changed in process of high temperature annealing. The nanoparticle size is determined by the X-ray diffraction and TEM. The luminescence measurements were performed at the SUPERLUMI station of HASYLAB at DESY.

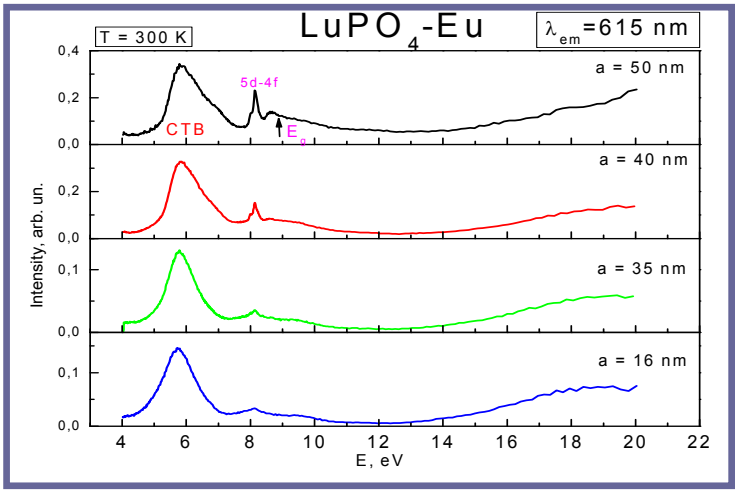

Fig.3 Luminescence excitation spectra of $LuPO_4$-Eu

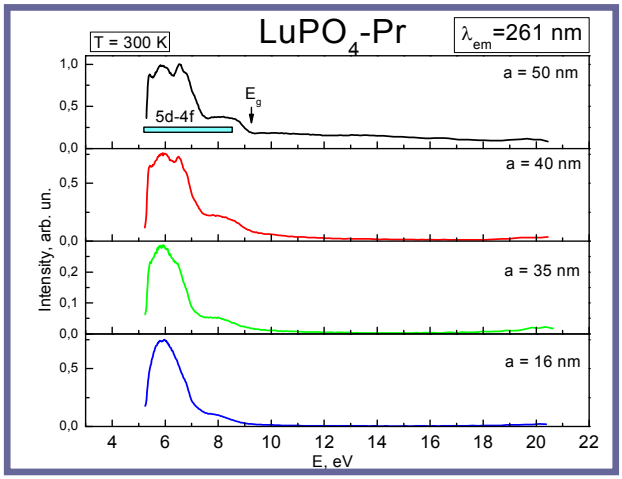

Fig.4 Luminescence excitation spectra of $LuPO_4$-Pr

Result and discussion

The emission spectrum of Eu^{3+} in $LuPO_4$-Eu nanoparticles with size of 8 and 16 nm is slightly broadened in comparison with luminescence spectra of Eu in samples with greater size (35-50 nm). In nanoparticles the impurity centers are mainly localized in near surface layer. Hence the photoelectrons have high probability to localize on Eu^{3+} ions and not on the near surface defects only. It creates the favorable conditions for further recombination of Eu^{2+} centers with less mobile holes. Slightly other dependence of luminescence parameters is observed in a case of electron recombination luminescence for $LuPO_4$-Pr. Here, the 5d-4f luminescence is preferably excited in the range of 4f-5d transitions in Pr^{3+} ions. As nanoparticle size is decreased the luminescence intensity of Pr^{3+} falls for quanta with $E>E_g$ and the range of luminescence excitation corresponding to multiplication of electronic excitation is not observed.