

Features of Ce^{3+} 5d – 4f luminescence from nanosized $La_{1-x}Ce_xF_3$ crystallites



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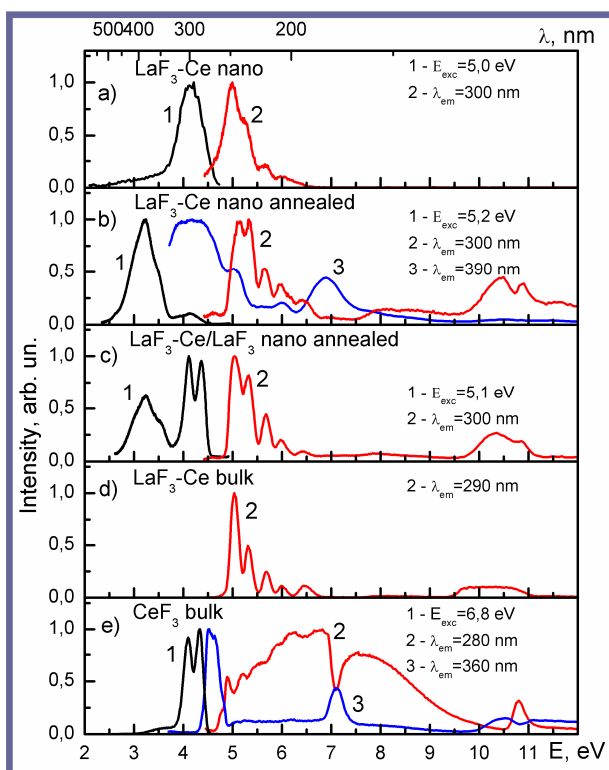


Fig. 1 The luminescence and excitation spectra of nano- and bulk LaF_3-Ce and CeF_3 crystals

Results and Discussions

During high-temperature annealing the CeF_3 nanoparticle embedded in LaF_3-Ce nanoparticles is formed. Under the assumption of small size of nanoparticles the excitation spectra of CeF_3 and LaF_3-Ce will be coincide, because the saturation effect and surface losses effect are absent. This feature has been observed for the excitation spectra of CeF_3 thin films with thickness around 352 nm and $CsPbCl_3$ nanocrystals embedded in $CsCl$ host. If we state about the coexistence of CeF_3 and LaF_3-Ce nanophases, other peculiarities of their luminescence can be explained. In particular, the decay curve of long-wave luminescence at the excitation of about 7 eV has long decay times inherent to a recombination luminescence. The appearance of a recombination process requires the participation of the band charge carriers. Therefore, we assume that the band with a maximum of about 7 eV could be caused by the $2pF \rightarrow 5d$ transitions, where the 5d-band has to be considered as conduction band. The threshold around 7.6 eV could correspond to $4f \rightarrow 6s$ transitions.

Introduction

The LaF_3-Ce is well known model system for the study of luminescence processes in scintillation materials. The study of this crystal in a considerable degree provides an opportunity to elucidate the energy transfer peculiarities in CeF_3 crystals and to explain the relatively low scintillation efficiency by the excitation mediated preferably the direct excitation of cerium ions.

Experiment

LaF_3-Ce nanoparticles as well as LaF_3-Ce coated by LaF_3 shell (LaF_3-Ce/LaF_3 , core/shell nanoparticles) were synthesized by the chemical reaction of lanthanum nitrate and cerium nitrate with ammonium fluoride and citric acid. Luminescent-kinetic studies of LaF_3-Ce and LaF_3-Ce/LaF_3 nanoparticles were carried out using SUPERLUMI facility, which provided the spectrum measurements with subnano-second time-resolution within 4–20 eV energy range for the luminescence excitation spectra and 6–1 eV for the luminescence spectra.

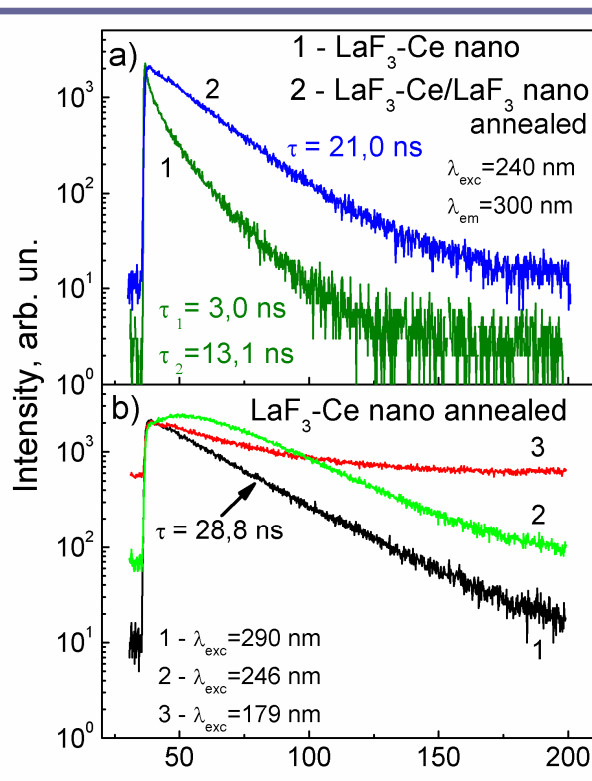


Fig. 2 The decay kinetics of LaF_3-Ce nanocrystals.