

Peculiarities of luminescence decay of Ce:LaF₃ nanoparticles depending on conditions of hydrothermal treatment

*Elena Lukinova**, *Eduard Madirov*, *Maxim Pudovkin*, *Daria Koryakovtseva*, *Stella Korableva*, *Alexey Nizamutdinov*, and *Vadim Semashko*

Kazan Federal University, Institute of Physics, 18 Kremlevskaja str., Kazan, 420008 Russia

Abstract. Luminescence decay properties of crystalline LaF₃ nanoparticles containing 12 % of Ce³⁺ ions collected at different stages of microwave hydrothermal treatment were studied. The microwave treatment has led to improvement of surface perturbed sites luminescence together with reducing PL decay time of regular sites apparently due to higher surface/volume ratio.

1 Introduction

Fluoride crystalline nanoparticles and LaF₃ particularly doped with RE ions exhibit prospective luminescent properties. Due to low-energy phonons these materials provide advantages in up-conversion and photosensitizing demanding applications [1,2] and open novel applications for quantum electronics and photonics [3].

The variation of synthesis conditions which leads changes in energy transfer processes between impurities and influences the luminescence quenching factors [2] opens the way to manage characteristics of materials. Aim of this work is to study luminescence decay properties of Ce³⁺ ions in LaF₃ nanoparticles after microwave hydrothermal treatment.

2 Experimental

The nanoparticles of LaF₃ doped with 12 % of Ce³⁺ ions were synthesized via co-precipitation method [3-5] and subsequent modification of prepared nanoparticles using the microwave-assisted hydrothermal treatment was performed [6]. Four samples collected at different stages of fabrication were investigated. Namely N1 sample was obtained right after precipitation procedure. The N2 sample was collected right after the pH was adjusted to 5-6 by adding 25% solution of ammonium hydrate and then stirred with heating for 2 hours. The remaining suspension was placed into the microwave oven for 30 minutes (sample N3) and 180 minutes (sample N4). All samples were washed with distillate water and separated from the suspension by centrifugation. The resulting product was dried at 60 °C for 12 h.

* Corresponding author: elena.v.lukinova@gmail.com

3 Results and discussion

Luminescence (PL) spectrum of Ce:LaF₃ sample N1 registered under 266 nm excitation (see Fig. 1a) appeared to be characteristic for all samples and coinciding with literature [2].

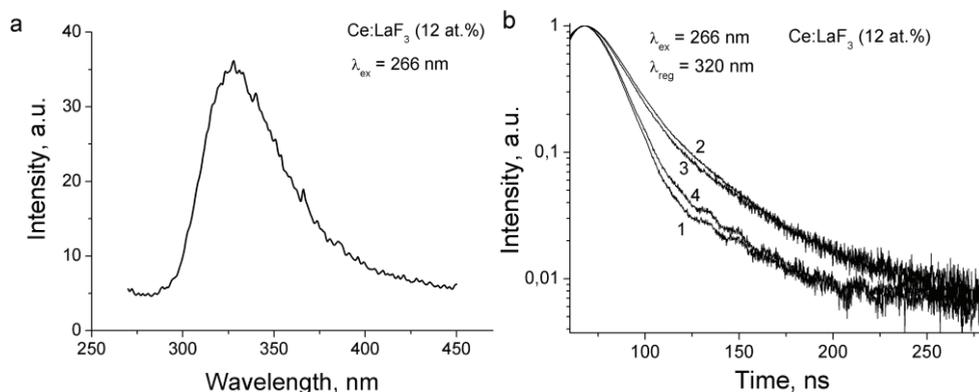


Fig. 1. Room temperature PL spectrum (a) and PL decay curves (b) of LaF₃:Ce (12 %) nanoparticles dried samples, 1 – N1 sample, 2 – N2 sample, 3 – N3 sample, 4 – N4 sample.

The decay curves of PL detected at 320 nm of all four samples of Ce:LaF₃ nanoparticles show fast and slow components (see Fig. 1b) determined by regular sites and perturbed sites relaxation respectively [2]. Results of the fitting the decays by two-exponential dependence are presented in Table 1. It is shown that both fast and slow components exhibit changes with synthesis procedure.

Table 1. Luminescence decay components of Ce:LaF₃ nanoparticles samples.

	LaF ₃ :Ce (N1)	LaF ₃ :Ce (N2)	LaF ₃ :Ce (N3)	LaF ₃ :Ce (N4)
t1, ns	55.6±0.5	36.6±0.5	38.2±0.5	43.1±0.5
t2, ns	8.1±0.5	9.8±0.5	10.1±0.5	7.9±0.5

It can be seen that stabilization of pH drops PL decay time for perturbed state and this can affect energy transfer to sensitizers. Also it is shown that microwave treatment somehow improves this effect together with reducing PL decay time of regular sites apparently due to higher surface/volume ratio.

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