

INVESTIGATION OF LUMINESCENCE PROPERTIES OF HYDROTHERMALLY SYNTHESIZED Pr³⁺ DOPED BaLuF₅ NANOPARTICLES UNDER EXCITATION BY VUV PHOTONS

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In recent years, ternary fluoride compounds have gained attention for potential applications as scintillators in medical imaging and high-energy physics [1]. In pursuit of such materials, we synthesized BaLuF₅:Pr³⁺(1%) nanoparticles using a one-step hydrothermal synthesis method. Synthesized nanoparticles were roughly spherical with an average particle size of 21±4 nm, and stable up to 600°C, as was confirmed by high-temperature X-ray diffraction analysis.

Time-resolved (TR) luminescence spectroscopy (incl. decay kinetics) of BaLuF₅:Pr³⁺(1%) nanoparticles under vacuum ultraviolet (VUV) photon excitation at the FinEstBeAMS beamline unveiled a two-photon emission process attributed to the ¹S₀ state positioned below the 4f¹5d¹ band of Pr³⁺ ions. Thus, no emissions assigned to the 4f¹5d¹→4f² transitions in Pr³⁺ were detected in the UV region. An intrinsic broad emission of self-trapped excitons (STE) was observed at 3.8 eV under host excitation. The band gap value ~12.4 eV was estimated from the excitation spectra. Time-resolved emission spectra measured under the excitation by 45 eV photons shown in two-time windows (STW: 0-1 ns and LTW: 1-300 ns) in Fig. 1 exhibited a series of slow Pr³⁺ 4f²→4f² emission bands as well as a fast-cross luminescence at 5 eV with a decay time of 160 ps corresponding to time-resolution of the setup. This CL band is due to the recombination of electrons from the F 2p valence band with Ba²⁺ 5p core holes. Time-resolved excitation spectra analysed within the same short time window revealed the onset of the CL excitation band at 18 eV assigned to the Ba²⁺ 5p level. The peculiarities of relaxation processes leading to either intrinsic (CL, STE) or Pr³⁺4f²→4f² transitions in BaLuF₅ nanoparticles under excitation in the Pr³⁺ 4f¹5d¹ bands as well as in excitonic band and fundamental absorption region will be discussed.

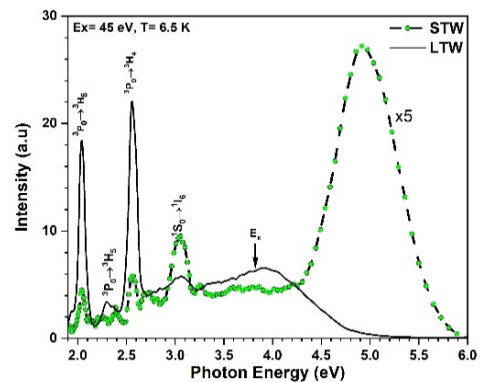


Fig. 1. TR photoluminescence spectra of BaLuF₅:Pr³⁺(1%) nanoparticles excited by 45 eV photons. It is presented in two-time windows i.e. STW: 0-1 ns LTW: 1-300 ns.

References

1. J. Saaring, A. Vanetsev, K. Chernenko, et al., *J. Alloys Compd.* 883, 160916 (2021).