Scintillation characteristic of Pr doped $La_2Si_2O_7$ single crystal by FZ-method

NAIST, ◦Prom Kantuptim, Masaki Akatsuka, Daisuke Nakauchi, Takumi Kato,
Noriaki Kawaguchi, Takayuki Yanagida
E-mail: prom.kantuptim.pf2@ms.naist.jp

The scintillator is a luminescence material which can convert a high energy photon and a particle of the ionizing radiation to the lower energy photons such as ultraviolet and visible light immediately after the absorption of the ionizing radiation. The emitted photons are collected by photodetectors and converted to the electrical signal for radiation detection purpose. At present, the single crystal type scintillators using the rare earth ions as the luminescence center have been commonly investigated from a fast response time, high light yield, and high effective atomic number [1]. Among luminescence center ions, Pr^{3+} is one of the highly attractive ions for this purpose from the result of fast scintillation decay time. In 2018, the Pr-doped $Lu_2Si_2O_7$ study had shown a very fast scintillation decay time around 15 ns with a light yield of 9,700 ph/MeV [2]. Form these great results, the searching of new host materials for Pr is becoming very interesting for the fast decay time scintillator. From the similar ionic radius between Lu and La, the lanthanum pyrosilicate ($La_2Si_2O_7$, LaPS) is expected to has high scintillation characteristics when doped with the Pr.

This study has aim to be the first report on Pr-doped LaPS focus on both optical and scintillation properties. Figure 1 (A) presents the Pr doped LaPS single crystal by the floating-zone method. The sample has yellow-green color and cracks throughout the crystal rod. Besides, the crack free part of the crystal was cut and polished (Fig. 1 (B)). After synthesis, the measurements were carried out, including PL spectra, PL decay times, scintillation decay times, afterglow, γ-ray irradiation pulse height spectra for scintillation light yield. Figure 2 presents X-ray induced scintillation spectra. The Pr-doped LaPS showed scintillations at 250, 300, and 350 nm, which were originated from the Pr^{3+} 5d-4f with difference ground states.

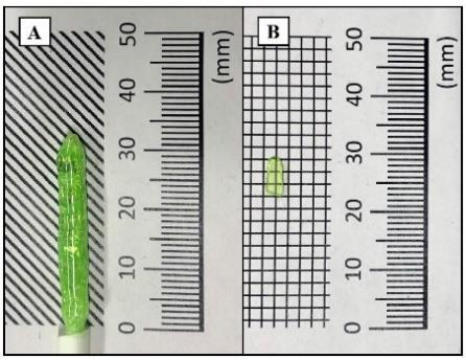

Figure 1. 10 % Pr doped LaPS crystals as-grown (A) and after cut and polished (B).

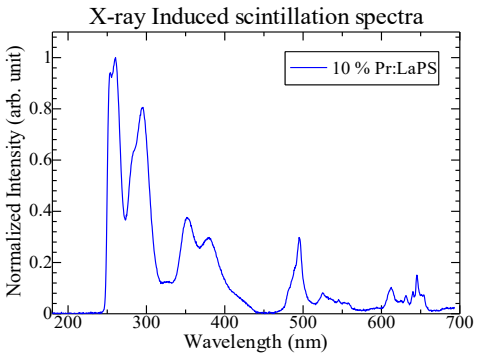

Figure 2. X-ray induced scintillation spectra of Pr-doped LaPS crystals.

[1] C. Van Eijk, *Nuclear Instruments and Methods in Physics Research A* 460 (2001) 1–14.
[2] Yanagida, *et al. Japanese Journal of Applied Physics* 57 (2018): 106401.