

## Optical and Scintillation Properties of Tb-doped $\text{La}_2\text{Si}_2\text{O}_7$ Crystal

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The scintillator is one of the phosphor materials that can convert the high-energy ionizing radiations such as photons (X- or  $\gamma$ -ray), neutron, or charged particles into lower-energy photons such as ultraviolet (UV), visible, and near-infrared light.[1] In the past, it was difficult to investigate the scintillation properties of Tb-doped scintillators due to limitations imposed by the pulse height setup, which resulted in an underestimation of the scintillation light yield of scintillators with a decay time in the ms range. A special pulse area setup has recently been developed for scintillators with ms decay time, using which a light yield for Tb-doped  $\text{Sr}_2\text{Gd}_8(\text{SiO}_4)_6\text{O}_2$  of 23,000 ph/MeV was reported. This study is the combination of the newly discovered pyrosilicate, the Lanthanum pyrosilicate  $\text{La}_2\text{Si}_2\text{O}_7$  (LaPS) single crystals.[2] LaPS single crystals were successfully fabricated by the floating zone (FZ) method with 0.1, 0.5, 1.0, and 2.0% Tb-doping concentrations for scintillation and photoluminescence (PL) study. X-ray diffraction patterns of the samples indicate a single phase of LaPS from their consistency with the reference pattern. Tb-doped LaPS has multiple emissions from  $\text{Tb}^{3+}$  4f-4f transitions including those at 380, 420, 440, 480, 540, 590, and 620 nm, as observed in both PL and X-ray-induced scintillation spectra (figure 1) with a PL quantum yield of up to 50.1%. The PL and scintillation decay time constants obtained were 2.64–3.26 and 1.54–2.00 ms, respectively. In the  $^{137}\text{Cs}$  (662 keV)  $\gamma$ -ray pulse area spectra, presented on figure 2, the 1.0% Tb-doped LaPS had the highest scintillation light yield of 47,700 ph/MeV. From all the results in this study, the optimum Tb-doping concentration in LaPS single crystal is considered to be at 1.0% for scintillator application

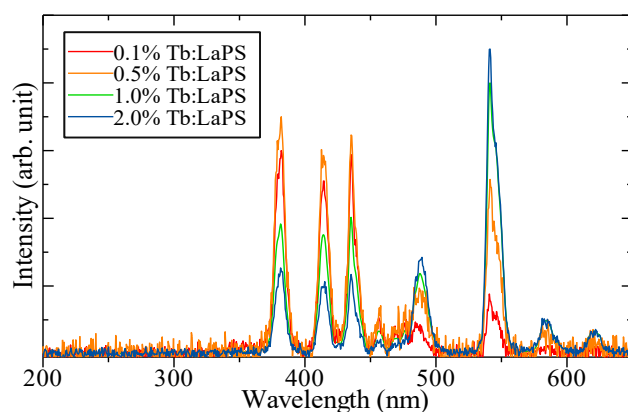


Fig. 1. X-ray induced scintillation spectra of Tb-doped LaPS samples.

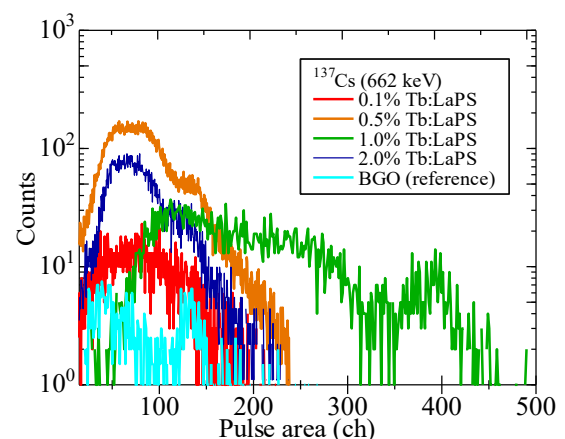


Fig. 2.  $^{127}\text{Cs}$  pulse-height spectra of Tb-doped LaPS samples and BGO reference

[1] T. Yanagida, *Proceedings of the Japan Academy, Ser. B* 94 (2018): 75.

[2] K. Watanabe, *et al. Japanese Journal of Applied Physics* 60 (2021): 106002.