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Comprehensive study on La-GPS scintillator

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Recently, Ce:(La, Gd)$_2$Si$_2$O$_7$ (Ce:La-GPS) scintillator was reported the have a good energy resolution (FWHM) of ˜5% at 662 keV, and its light output remained constant up to 150 °C (423K) [1,2]. Moreover, we grew larger size Ce:La-GPS crystals by Czochralski process up to 2 inch diameter and studied their scintillation properties. Up to now, we have shown the scintillation properties of fixed La-concentration, and we have never revealed the La-concentration dependence of some properties such as bandgap energy, light output at high temperatures, rising time, etc. In this paper, we show the Comprehensive study on La-GPS scintillator with a La concentration of 20 –50% in the Gd site.

Ce-doped and pure Ce:(La$_x$, Gd$_{1-x}$)$_2$Si$_2$O$_7$ crystals were grown by the micro-pulling down method from the starting materials: 99.99% pure Gd$_2$O$_3$, La$_2$O$_3$, SiO$_2$ and CeO, where x = 0.2 to 0.5. The crystals were confirmed to have single phase using X-ray diffraction patterns.

For Ce-doped samples, after cutting and polishing the samples, transmittance and photo-luminescence (PL) excitation and emission spectra were measured using a spectrophotometer (V-530, JASCO) and a spectrofluorometer (FLS920, Edingurgh Instrument: EI) with Xe lamp (EI, Xe-900), respectively. The pulse height spectra at the high temperature up to 200 °C (473K) were measured with a ruggedized PMT (Hamamatsu R1288AH) in order to evaluate the temperature dependence. To evaluate the bandgap energy, transmittance spectra of pure La-GPS samples were measured at low temperature (7K) using a beam-line at a synchrotron faculty, Ultraviolet Synchrotron Radiation Facility (UVSOR), in Japan.

We found that both samples had almost the same emission and excitation spectra and good light output over 150°C (423K). The band gap energies did not depend on the La-concentration, and the energies were estimated to be around 7.1 –7.2 eV. We show the above results, rising time for the samples and the temperature dependence of light output or intensity from 7 to 500K in this presentation.

[1] A. Suzuki, S. Kurosawa, and A. Yoshikawa et al., Appl. Phys. Express 5 (2012) 102601.

[2] S. Kurosawa, and A. Yoshikawa et al., NIMA 772 (2015) 72.

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