Scintillation Properties of Tb-doped Gadolinium Pyrosilicate 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 γ-ray), neutron, or charged particles into lower-energy photons such as ultraviolet (UV), visible, and near-infrared light. The combination of scintillator and photodetector has been widely used for radiation detection systems in many scientific fields. In 2003, the Ce-doped $Lu_2Si_2O_7$ (LPS) study presented a high light yield of 26,300 ph/MeV with a fast decay time of 36 ns.[1] For the luminescence canter, Tb^{3+} is famous for the green emission of 4f-4f transitions. However, in the past, the study of scintillation properties of Tb^{3+} scintillator was difficult due to the limitation of the instrument setup. Until recently, the pulse height system for the scintillator with millisecond decay time has been successfully developed.[2] This study is focused on the combination of Tb^{3+} with the gadolinium pyrosilicate, $Gd_2Si_2O_7$ (GPS). The Tb-doped concentration dependence on both photoluminescence and scintillation properties is focused.

Figure 1 presents the Photograph of polished Tb-doped GPS crystals. In room light, samples are transparent and colorless. However, under the 254 nm UV, Tb-doped GPS has a different color of luminescence from blue to green upon the rising of Tb-doped concentration. One of the highlight properties is ^{127}Cs pulse-height spectra presented in figure 2. Tb-doped GPS has a scintillation light yield up to 95,600 ph/MeV (0.5% Tb). Apart from the light yield, this study is also containing other comprehensive properties of Tb-doped GPS for scintillator applications.

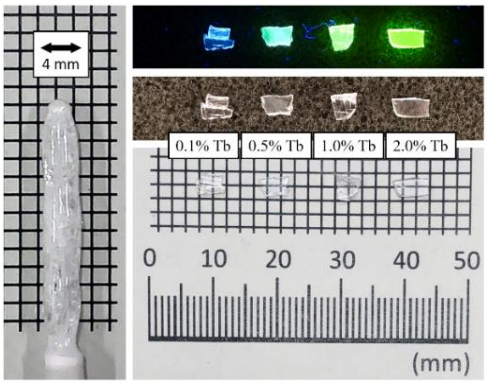

Fig. 1. Photographs of Tb-doped GPS single crystal as-grown, cut, and under 254 nm UV.

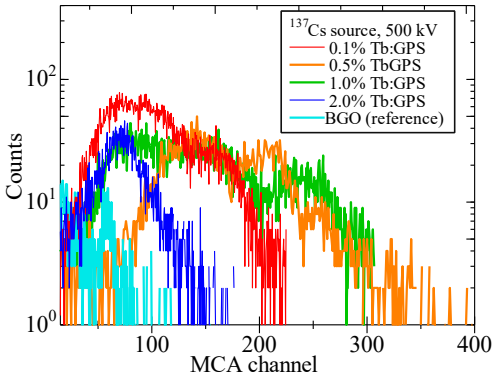

Fig. 2. ^{127}Cs pulse-height spectra of Tb-doped GPS samples and BGO reference

[1] L. Pidol, *et al*. *Journal of Physics Condensed Matter* 15 (2003): 2091.

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