

Scintillation Characteristics of LaNbO₄ Single Crystals

Yuma Takebuchi^{1,#}, Reiji Yamashiro¹, Hiromi Kimura², Daisuke Nakauchi³,
Kazuhiro Yamaki¹, Keitaro Tezuka¹, Takayuki Yanagida³

¹Utsunomiya University, ²National Institute of Advanced Industrial Science and Technology,
³Nara Institute of Science and Technology

Phosphors exhibiting intrinsic luminescence require no impurities to act as luminescence centers, and homogeneous crystal growth is possible, making them suitable for scintillators in terms of high light yield and high energy resolution. Rare-earth niobates exhibit intrinsic luminescence owing to [NbO₄]³⁻. In particular, because LaNbO₄ has a narrow band gap (~4.8 eV) and congruently melts at a low temperature (~1650 °C), LaNbO₄ is suitable for scintillators [1,2]. In this study, LaNbO₄ single crystals were synthesized, and their luminescence properties were investigated. The as prepared sample and the samples subjected to oxidation and reduction annealing are referred to as the As-prepared, O₂, and H₂ samples, respectively.

Figure 1 shows the X-ray-induced scintillation spectra of the synthesized LaNbO₄ single crystals. All the crystals exhibited an emission peak and shoulder at approximately 410 and 480 nm, respectively. This luminescence is attributed to charge transfer between Nb⁵⁺ and O²⁻ [3]. Compared with the As-prepared sample, the luminescence intensity of the O₂ sample increased, whereas that of the H₂ sample decreased. To quantitatively reveal the effect of annealing, the ¹³⁷Cs- γ irradiated pulse height spectra of each sample were measured, as shown in Fig. 2. A clear photoelectric absorption peak was observed in all the samples. The light yields were calculated by referring to a commercial Ce-doped Gd₂SiO₅ (Ce-GSO: 7000 ph/MeV). The light yields were 8700, 9400, and 7300 ph/MeV for the As-prepared, O₂, and H₂ samples, respectively. The increase of light yield in the O₂ sample is attributed to the suppression of oxygen defects.

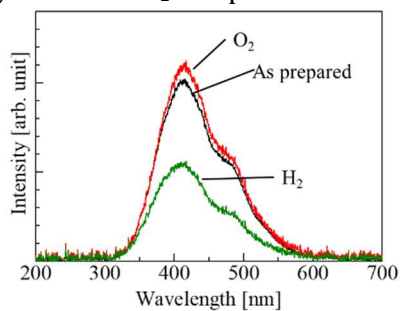


Fig. 1. X-ray-induced scintillation spectra of LaNbO₄ single crystals.

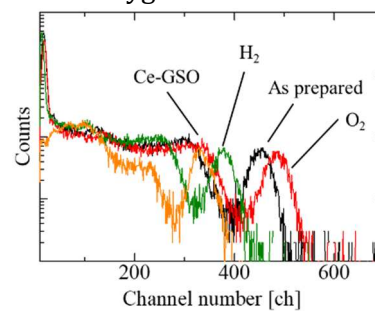


Fig. 2. ¹³⁷Cs irradiated pulse height spectra of LaNbO₄ single crystals and Ce-GSO.

[1] Y. J. Hsiao *et al.*, (2007) *J. Lumin.*, 126, 866. [2] H. Takei *et al.*, (1977) *J. Cryst. Growth*, 38, 55. [3] S. Ding *et al.*, (2018) *Solid State Commun.*, 277, 7.

corresponding author: takebuchi@a.utsunomiya-u.ac.jp