Crystal growth of Eu-doped (Y, Lu)ScO_3 by micro-pulling-down method using W crucible

Yuka Abe[1,2], Takahiko Horiai[2,3], Yuui Yokota[2,3], Masao Yoshino[2,3], Rikito Murakami[2], Takashi Hanada[2], Akihiro Yamaji[2,3], Hiroki Sato[2,3], Yuji Ohashi[2,3], Shunsuke Kurosawa[2,3], Kei Kamada[2,3], and Akira Yoshikawa[2,3]

[1]*Graduate School of Engineering, Tohoku University, Japan*
[2]*Institute for Materials Research, Tohoku University, Japan*
[3]*New Industry Creation Hatchery Center, Tohoku University, Japan*

Introduction The luminescence thermometry has drown considerable attention because of its fast response and applicability in harsh environments and high electromagnetic fields [1]. In particular, rare-earth ion doped $Y_3Al_5O_{12}$ (YAG) has been widely studied and is expected to be used in the luminescence thermometry. For example, the temperature dependence of the decay time of Eu-doped YAG has been investigated and it was shown that temperatures can be accurately measured in the temperature range from 1000 K to 1470 K [2]. To further improve the properties, we focused on the sesquioxide such as Sc_2O_3, Y_2O_3 and Lu_2O_3, which have been reported to have higher thermal conductivity than YAG. Thus, in this study, we grew Eu-doped (Y, Lu)ScO_3, crystals with Lu substitution at the Y site of $YScO_3$ and evaluated the effect of Lu substitution on the crystal structure and optical properties.

Materials and Methods The crystal growth was performed using micro-pulling-down (μ-PD) method [3]. Y_2O_3, Lu_2O_3, Sc_2O_3 and Eu_2O_3 powders were used as starting materials and sintered at 1700°C for 30 hours in air. The sintered compacts were filled into the W crucible, and the crystals were grown using metal W rod as seed crystal at a pulling down rate of 0.05 mm/min. The crystal structure of the grown crystals were estimated by the powder X-ray diffraction (XRD) analysis. In addition, the photoluminescence (PL) excitation and emission spectra were measured and the effect of Lu substitution on emission was evaluated.

Results Transparent Eu:(Y, Lu)ScO_3 crystals were succeeded in growing. From the results of the powder XRD patterns, the crystalline system and space group of the grown crystals were identified cubic and Ia-3, respectively. PL emission spectra were measured in the wavelength range of 275-750 nm with excitation at 253 nm. From the PL emission spectrum, the sharp emission peaks due to the Eu^{3+} 4f-4f transitions from $^5D_0$ to lower lying ^7F_J levels were observed. Details of the crystal structure and optical properties of Eu-doped (Y, Lu)ScO_3 crystals will be presented.

[1] X. Wang, et al., Luminescent probes and sensors for temperature, Chem. Soc. Rev., 42 (2013) 7834–7869.

[2] T. Kissel, et al., Phosphor thermometry: On the synthesis and characterisation of $Y_3Al_5O_{12}$:Eu (YAG:Eu) and $YAlO_3$:Eu (YAP:Eu). Mater. Chem. Phys., 140 (2013) 435–440.

[3] A. Yoshikawa, et al., Challenge and study for developing of novel single crystalline optical materials using micro-pulling-down method. Opt. Mater., 30 (2007) 6–10.