Fabrication of (001)-$Sn_5P_2O_{10}$ thin films on quartz by inserting Y_2O_3 buffer layer

○Michitaka Fukumoto[1,2], Chang Yang[1], Wenlei Yu[1,3], Christian Patzig[4], Thomas Höche[4],
Tetsuya Hasegawa[2], Michael Lorenz[1], Marius Grundmann[1]
Leipzig University[1], The University of Tokyo[2], Wenzhou Medical University[3], Fraunhofer IMWS[4]
E-mail: pon@chem.s.u-tokyo.ac.jp

Introduction: Transparent electrodes based on wide gap oxide semiconductors are important components of solar cells and flat panel displays. So far, such applications were limited by the lack of practical p-type TCOs. Recently, $Sn_5P_2O_{10}$ has been predicted as one of the promising p-type TCOs by a theoretical calculation [1]. However, $Sn_5P_2O_{10}$ has been synthesized only in powder form and its physical properties have not been investigated yet [2]. In this study, we fabricated phase-pure $Sn_5P_2O_{10}$ thin films for the first time by pulsed laser deposition (PLD) and investigated their optical properties. The crystal orientation of the film is controllable even on amorphous quartz substrates by inserting a Y_2O_3 buffer layer.

Experimental: $Sn_5P_2O_{10}$ thin films were fabricated on Y_2O_3-buffered quartz substrates by PLD. Crystal structure and optical properties of the obtained films were measured by X-ray diffraction (XRD) and UV/visible/near infrared spectrophotometer, respectively.

Results: Fig. 1 shows θ-2θ XRD patterns of the obtained films. 00*l* diffraction peaks of $Sn_5P_2O_{10}$ and *hhh* peaks of Y_2O_3 were clearly observed, indicating successful growth of (001)-oriented $Sn_5P_2O_{10}$ films on (111)-oriented Y_2O_3 buffer layers. Fig. 2 shows transmittance spectra of the $Sn_5P_2O_{10}/Y_2O_3$ films, plotted together with the transmittance of a reference Y_2O_3 film. The $Sn_5P_2O_{10}/Y_2O_3$/quartz sample exhibited high transparency in the visible light region (~80%). The bandgap of the obtained film was determined to be 3.87 eV, which agrees well with the bandgap predicted by theoretical calculation.

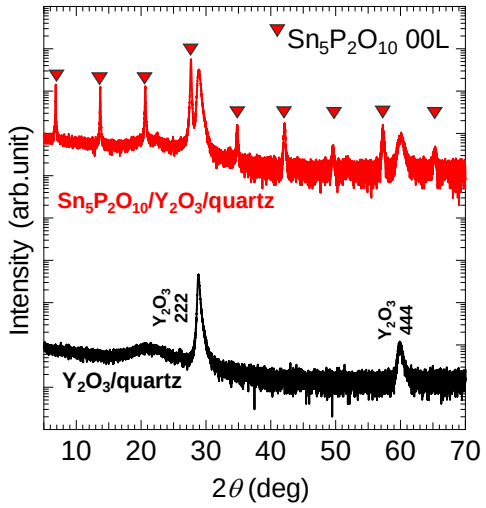

Fig. 1. θ-2θ XRD patterns of $Sn_5P_2O_{10}/Y_2O_3$/quartz and reference Y_2O_3/quartz samples.

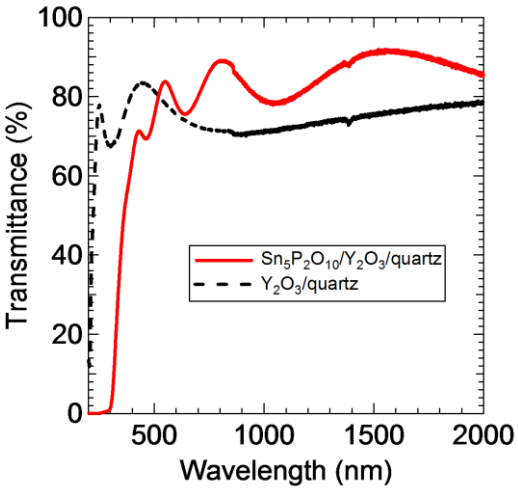

Fig. 2. Transmittance spectra of the $Sn_5P_2O_{10}/Y_2O_3$/quartz and reference Y_2O_3/quartz samples.

[1] Q. Xu *et al.*, Chem. Mater. **29**, 2459–2465 (2017).
[2] L.-Q. Fan *et al.*, Z. Anorg. Allg. Chem. **634** 534 (2008).