MBE による MgO(100)基板上への Al ドープ ZnCdO 薄膜の成長

Growth of Al-doped ZnCdO thin films on MgO substrates by molecular beam epitaxy

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1. Introduction

Rocksalt (rs) $Zn_{1-x}Cd_xO$ (ZnCdO) is expected to use as a transparent conductive oxide (TCO) because of high transparency in wide wavelength range [1,2]. In the previous study, we found that the largest band gap of 3.1 eV was obtained in ZnCdO with Cd composition x~0.6. However, as compared to other TCO materials, the band gap energy is still low and must be improved. Since it is difficult to decrease Cd composition due to the phase transition, the increase of an electron concentration might be effective to improve the optical band gap by the Burstein-Moss shift.

Here, we have investigated the effect of Al-doping on the structural, optical and electrical properties in ZnCdO.

2. Experimental

Al-doped ZnCdO thin films were grown on MgO (100) substrates at the substrate temperature of 250 °C by MBE. The Cd flux ratio (f_{Cd}= [Cd]/([Cd]+[Zn])) was changed to control the Cd composition. Al flux was set to 2.0×10^{-7} Pa. The films were characterized using x-ray diffraction (XRD), energy dispersive x-ray spectroscopy (EDX), reflection high-energy electron diffraction (RHEED), hall-effect measurement, and transmittance and reflection measurements.

3. Results and discussion

Figure 1 shows the XRD profiles of Al-doped ZnCdO thin films grown under various Cd flux ratios. The diffraction peak from the rs-(200) was detected at $f_{Cd} \geq 0.93$ while the peak from wurtzite (0002) was observed at $f_{Cd} \leq 0.91$, indicating that Al-doped ZnCdO with rocksalt structure was epitaxially grown on the MgO substrate when $f_{Cd} \geq 0.93$.

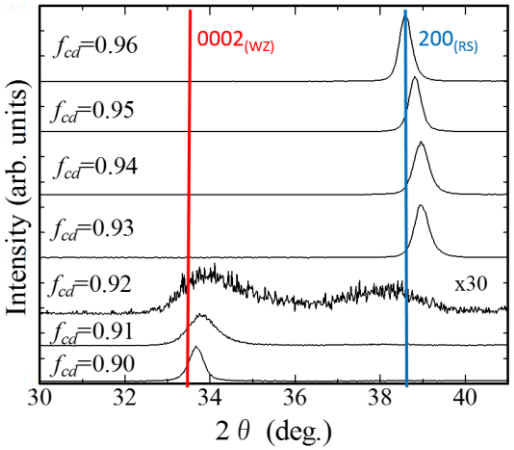

Figure 1. XRD profiles of Al-doped ZnCdO thin films grown on MgO substrate under various Cd flux ratios.

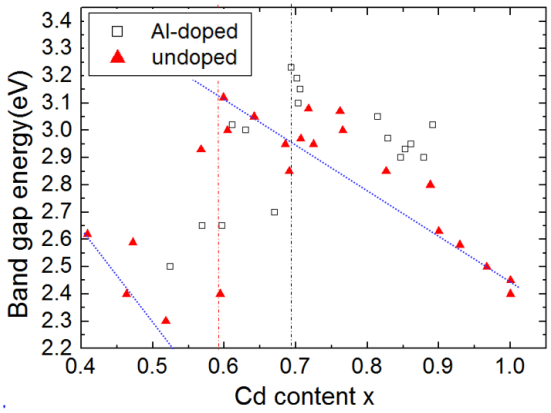

Figure 2. Comparison of band gap energies of Al-doped and undoped ZnCdO thin film.

Figure 2 shows the band gap energy of undoped and Al-doped ZnCdO thin film determined by the square plot of absorption coefficients. The band gap energy for Al-doped ZnCdO was higher than those for undoped ZnCdO due to the increase of electron concentration by Al doping.

References

[1] K. M. Yu et. al. J. Appl. Phys. 111 (2012)123505.

[2] D. M. Detert et al. Appl. Phys. Lett. 102 (2013) 232103