27a-PB3-2

BeO-ZnO 混晶薄膜の作製

Fabrication of BeO-ZnO alloy phase thin films

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Wide-gap semiconductors are used in various optoelectronic, high-power and high-temperature applications. Wide-gap materials that do not contain heavy elements may have additional advantages in environments with heavy high-energy radiation loads, such as aerospace electronics and detectors in high-energy physics. Especially for optoelectronic and detector applications, a material where the band gap can be adjusted by alloying has great advantages.

In this work, we focus on thin film alloys of BeO (E_g=10.6 eV) and ZnO (E_g=3.37 eV), grown by Pulsed Laser Deposition (PLD) on sapphire and $SrTiO_3$(111) substrates. The interest of this alloy system was triggered by reports of BeZnO growth covering the full Be composition range[1]. Our purpose is to determine the alloying limits for BeO in ZnO for thin films grown by PLD.

A high-frequency, high-brillance excimer laser (TuiLaser, BraggStar: 248 nm, 10 mJ, 200 Hz) was used for ablation, promoting multi-photon adsorption in the target and making it possible to evaporate pure BeO.

We report the successful growth of $Be_xZn_{1-x}O$ alloy films with doping levels of up to x=15%. Figure 1 presents an X-ray diffraction pattern of a film with x=13%. The deposition temperature and pressure strongly affected the stability of BeO films. The growth rate of BeO drastically dropped for temperatures over 500°C. Since the optimal growth temperature for ZnO is higher, the alloy films were deposited at 500°C and then post-annealed at 700°C. The Be concentration was controlled by alternately ablating pure BeO and ZnO ceramic targets and varying the ratio of ablation pulses. The maximum Be concentration in the films appears to be limited by re-sputtering of lighter Be atoms by the heavier Zn atoms in the ablation plume. The preferential re-sputtering of Be was probed by comparing the compositions of films grown by the alternating target method and by depositing from a mixed-phase target with the same nominal Be/Zn ratio.

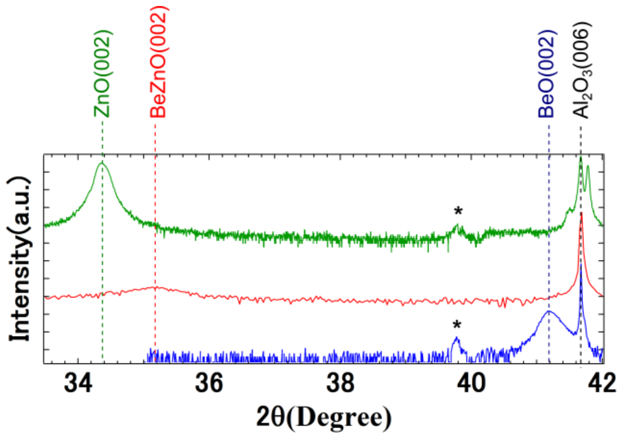

Figure1: XRD pattern of ZnO, BeO and BeZnO film. The Be concentration is computed using Vegard's law and it gives 13%. * Sample Holder

[1] Y. R. Ryu et al., Appl. Phys. Lett. **88**, 052103 (2006)