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Magnetic and Electrical Properties of $Zn_{1-x}Co_xO$ Thin Films Prepared by Pulsed dc Magnetron sputtering

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1. Introduction

Diluted magnetic semiconductors (DMS) have been of much interest because of their potential application to optoelectronics, magnetoelectronics, and microwave devices. Among them, II-IV semiconductors have an advantage, where concentration of charge and spin can be controlled independently by changing the concentrations of dopant elements. Especially, ZnO is one of the best candidates because recent researches predicted room temperature ferromagnetism in transition metal-doped ZnO[1,2]. Therefore, in this study, Co-doped ZnO thin films were deposited on glass by pulsed dc magnetron sputtering method and the magnetic and electrical properties of the films were studied.

2. Experiment

$Zn_{1-x}Co_xO$ (x=0-0.25) films were grown on corning 7059 glass by pulsed dc magnetron sputtering. The substrate temperature varied from 400 to 700℃ and the mixed plasma of Ar and O_2 were used for sputtering. The power applied to the target is 200 W with the pulse frequency of 30 kHz. The crystallinity and the orientation of the grown films were investigated by X-ray diffraction (XRD) (Cu Kα) method. Magnetic measurements were performed using an alternating gradient magnetometer (AGM) system at room temperature. Also, electrical resistivity, carrier concentration and mobility were investigated by van der pauw method.

3. Results and discussion

The results of XRD measurements on $Zn_{90}Co_{10}O$ films prepared as a function of O_2 mole fraction of plasma gas were investigated and were shown in Fig.1. The films were highly oriented to the c-axis without any other phase, and (002) peak position was shifted toward a lower values as O_2 mole fraction increased. It indicated that the (002) d-spacing of films increased with the increase of O_2 mole fraction. Fig. 2 showed XRD patterns of $Zn_{90}Co_{10}O$ films prepared as a function of substrate temperature. All the samples showed homogeneous ZnCoO phase without any Co impurities regardless of substrate temperature, indicating that Co ions were substituted to Zn sites in $Zn_{90}Co_{10}O$ films. From based on these XRD results, we studied magnetic and electrical properties of $Zn_{1-x}Co_xO$ (x=0-0.25) films and attempted to clarity the origin of ferromagnetism in ZnO based DMS.

4. References

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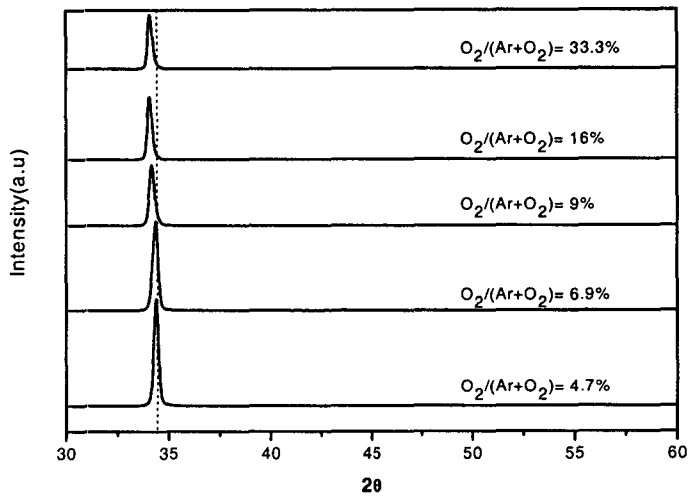

Fig. 1. XRD patterns of $Zn_{90}Co_{10}O$ films prepared as a function of O_2 mole fraction.

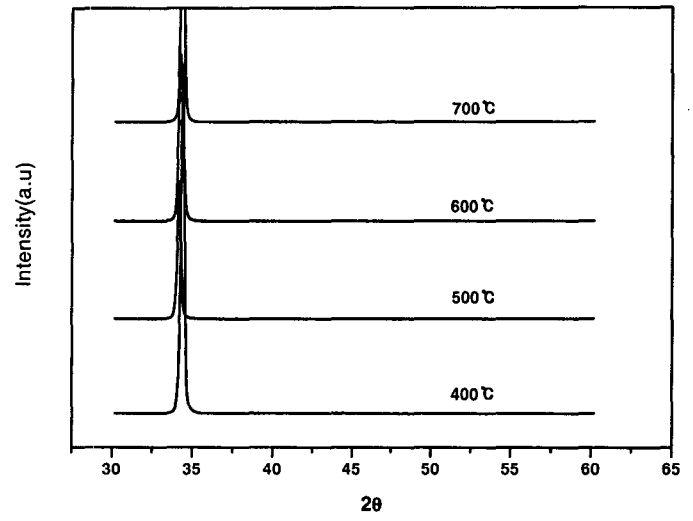

Fig. 2. XRD patterns of $Zn_{90}Co_{10}O$ films prepared as a function of substrate temperature