Effect of Growth Temperature on the Structural and Optical Properties of Gd-doped Zinc Oxide Thin Films

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초 록: Gd-doped ZnO thin films were prepared with different growth temperatures by using a radio-frequency magnetron sputtering method. The deposited samples were characterized by using the X-ray diffractometer, the scanning electron microscopy, and the photoluminescence spectroscopy. All of the films show an average transmittance of about 85% in the wavelength range from 400 to 1100 nm.

1. 서론

Recently, the rare earth doping into semiconductor has attracted much attraction due to its potential use in magnetoelectronic devices[1]. The effects of gadolinium doping on the structural and optical properties of zinc oxide (ZnO) thin films are of importance in understanding the origin of the ferromagnetism as well as for developing optoelectronic devices. In this work, we report a study of structural and optical properties of ZnO thin films doped with 1 wt.% as a function of growth temperature. The Gd-doped ZnO thin films have been grown on 10x10 mm^2 glass substrates by radio-frequency magnetron sputtering method. The experiments are carried out to investigate how the growth temperature, varied with 25, 100, 200, 300, and 400°C, influences the film's structure, the carrier concentration, and the optical band gap energy.

2. 본론

ZnO:Gd (1 wt.% Gd) target was prepared by using the conventional solid-state reaction method with ZnO (99.99%) and Gd_2O_3 (99.9%) as the starting materials. The structural and morphological properties of the ZnO:Gd thin films were characterized by using XRD and FE-SEM measurements. The XRD spectrum for the ZnO:Gd thin film deposited at 25°C exhibits one strong peak centered at 34.3° with the full width at half-maximum (FWHM) of 0.354°. This peak corresponds to the diffraction from the ZnO (002) plane. The FWHM decreases gradually from 0.354° to 0.342° as the growth temperature is increased up to 300°C. As for the ZnO:Gd fim deposited at 400°C, the intensity of the ZnO (002) diffraction peak is the most intense. As for the optical properties of the ZnO:Gd thin films, the optical band gap is obtained from the Tauc's model and parabolic relation and its value is estimated to be 3.18 eV for the ZnO:Gd thin film deposited at a growth temperature of 400°C. As the growth temperature is decreased to 300, 200, 100, and 25°C, the optical band gap gradually decreases to 3.16, 3.12, 3.11, and 3.11 eV, respectively. The absorption edge for the ZnO:Gd thin films deposited at 25°C is observed at 387.7 nm, and a blue shift of the absorption edge occurs with increasing growth temperature. The difference in absorption edges for the two samples deposited at 25°C and 400°C was found to be 8.1 nm.

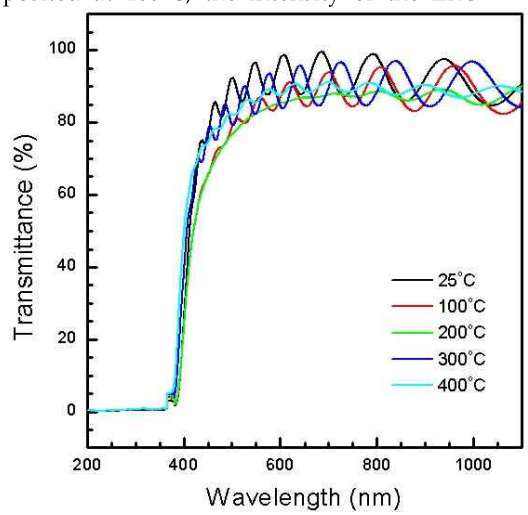

Fig. 1. Transmittance for the Gd-doped ZnO thin films deposited at various growth temperatures.

3. 결론

The trivalent gadolinium ions-doped ZnO thin films were prepared with changing the growth temperature. The optical band gap and the grain size depend significantly on the growth temperature.

참고문헌

1. T. Ohtake, S. Hijii, N. Sonoyama, and T. Sakata, Appl. Surf. Sci., 253 (2006) 1753.