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Effect of Fe- Doping on Optical Properties of Zno Thin Films

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ABSTRACT *This paper deals a simple non-alkoxide for depositing Fe- doped ZnO transparent conducting thin films on glass substrate by Spin coating method. 2-methoxyethanol and mono-ethanolamine were used as the solvent. The optical properties of the spin-coated ZnO: Fe thin films on glass were examined at different Fe dopant concentrations. The change in optical properties were investigated as a function of the Fe concentration.*

KEYWORDS : ZnO, UV spectroscopy, Dopant, Photoluminescence

Introduction

The field of nanocrystalline materials has been widely investigated in recent years for the improvement of magnetic, chemical and mechanical properties [1]. The diluted magnetic semiconductor (DMS) has attracted the attention of researchers; a fraction of the host cations can be substitutionally replaced by magnetic ions. This class of semiconductors has potential use of both charge and spin of electrons for spintronic devices such as spin-valve transistors, spin lightemitting diodes, logic devices and nonvolatile memory [2]. In this regard, ZnO has become a significant DMS material for its 3.37 eV wide direct band gap at room temperature and high chemical and thermal stabilityŒ3; 4 . Hence, significant research has been conducted to develop highly oriented ZnO thin films to expand their potential optoelectronic applications in various fields like transparent electrode in display, window layers in solar cells, field emitters, ultraviolet laser emission, photodetectors, piezoelectricity, bio-sensors and short wavelength LED [3]. Optical properties of the film have been investigated and the effect of doping and valence state of the Fe have been analyzed to explain the observed phenomena [4].

Experimental

The Fe-ZnO thin films were prepared by dissolving and in 2-methoxyethanol, to which a surfactant, mono-ethanolamine; was subsequently added. The molar ratio of MEA to was 0.02. The atomic fractions of $Fe(NO_3)_3$ in the ZnO thin films were 0, 1, 3 and 5% and samples are termed as a, b, c, d respectively. The obtained sol was dropped onto the substrate fixed on the spin coater and then spun at 2400 rpm for 60 seconds. Further, these films were then annealed at 400 for 2 h to crystallize the deposited films. The optical transmittance in the visible wavelength was measured using UV-visible spectrometer (UV-VIS-NIR JASCO V-670).

Influence of Fe-Doping on the optical Properties of ZnO Thin Films

Optical characterization has been done with UV spectroscopy using UV spectrophotometer (Jasco V-670 japan) with a photon wavelength range 200-1100 nm. Fig. (a) shows the transmission spectra of Fe-doped ZnO thin films deposited on glass substrate. For all the samples, they have high transmittance in the visible range; the average transmittance is above 82%. So, when Fe-doping concentration is not more than 5 at%, Fe-incorporation has little effect on the transmittance of ZnO thin films in the visible range. However, it was found that the transmittance in the visible range obviously decreased when ZnO thin films were doped with high Fe concentration. It is clear that all the samples have a sharp absorption edge of ZnO thin film shifts towards short wavelength direction. So, the blue shift of absorption edge occurred. It can be seen that the optical band gap gradually increased with the increasing Fe-doping concentration.

Fig. (b) shows the photoluminescence emission spectra of the pure ZnO and Fe-doped ZnO films. It can be seen all the films exhibit two kinds of emission peak at UV and visible range. When Fe concentration in the film is enhanced, the peak intensity of the UV emission increases, whereas the visible emission intensity decreases. The result suggests that the lattice of Fe-doped ZnO films has fewer oxygen vacancies and interstitial oxygen ions compared to pure ZnO.

Conclusion

Based on the research results of Fe-doped ZnO materials reported by us, it is considered that the valence state of Fe plays a great role in the variation of properties of ZnO thin films. UV spectroscopy reveals that introducing doping primarily deteriorates optical properties although 3 at% Fe-incorporation can improve the crystalline quality and transmission of ZnO film. However, more Fe-incorporation again deteriorates the crystalline quality and visible region transmission.

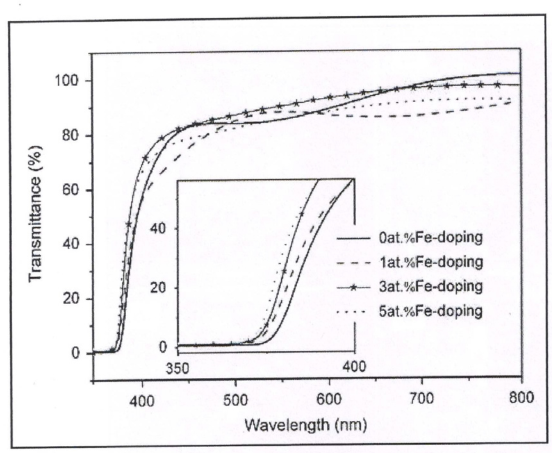

Fig. (a) Transmittance Spectra for ZnO Thin Films

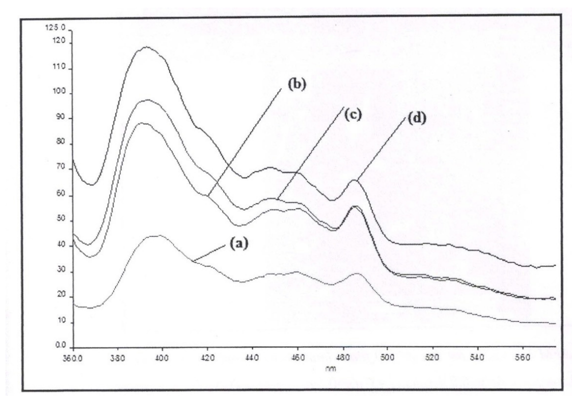

Fig. (b) Photoluminescence Spectra for ZnO Films

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