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Research Article

PRODUCTION AND INVESTIGATION ABOUT STRUCTURAL PROPERTIES OF AL DOPED ZNO THIN FILMS BY CHEMICAL BATH DEPOSITION

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ABSTRACT

Aluminum doped Zinc Oxide thin films were deposited on glass substrates by chemical bath deposition technique. The effects of the doping concentration on the structural properties of ZnO films were studied. Crystalline structures were investigated by XRD and SEM analysis. By doping Al impurity to ZnO layers grains of AZO growth with cubic structure and crystalline intensities decreased.

***Keywords**: Zinc Oxide, Aluminium, Doping, Structural Properties, Chemical Bath Deposition*

INTRODUCTION

Zinc oxide (ZnO) have been studied for applications to sensors, transparent electrodes in displays, heatmirrors and transparent conductive oxide (TCO) coatings for solar cells (Stambolova *et al.*, 2000; Chen *et al.*, 2001). ZnO thin films have attracted considerable attention because they can be tailoredto possess high electrical conductivity, high infrared reflectance and high visible transmittance by different coating technique (Ryu *et al.*, 2000).

Un doped and doped ZnO thin films have been developed bysputtering, pulsed laser deposition, chemical bath deposition, metal-organic chemical vapor deposition and atomic layer deposition techniques (Shanmuganathan *et al.*, 2013; Kim *et al.*, 2007). Optical and Magnetic properties were improved by various doping materials to ZnO. The aim of this work is to produce AZO thin layer with different concentration of Al^{3+} ionsand investigated about their structure and crystalline properties by SEM and XRD analysis.

Experimental Details

Al-doped ZnO films were produced by the CBD technique on glass substrates. The substrates were vertically immersed within the chemical bath using holders. The chemical bath was composed by 90 ml of $ZnCl_2$ (0.02 M), 4.3 ml of NH3. The chemical solution was magnetically stirred and fixed to a temperature of 65 ºC throughout the whole deposition process. $AlCl_3$ solutions atdifferent concentrations were used as doping agents for ZnO films. The concentration of Al^{3+} ions were 0.9M and 1 M in this work.

The structural and crystalline properties of Al doped ZnO films were investigated by SEM and XRD analysis.

RESULTS AND DISCUSSION

Figure 1 shows ZnO thin layers produced on glass substrate at 85 ºC for 50 minutes by CBD method. As it can be seen ZnO hexagonal grains configure on layer and nucleation process happens. By doping Al impurity with Ion concentration ratio $[Al^{+}/Zn^{+}]$=0.9 to ZnO layer, ZnO hexagonal grains break down and almost cubic like grains are produced on layer and also void fraction decreases, that should be because of high correlation energy between glass substrate and AZO grains (Figure 2). In Figure 3, the density of Al impurity increases to Ion concentration ratio $[Al^{+}/Zn^{+}]$ =1 and as it can be seen surface is full of AZO grains with cubic structure.

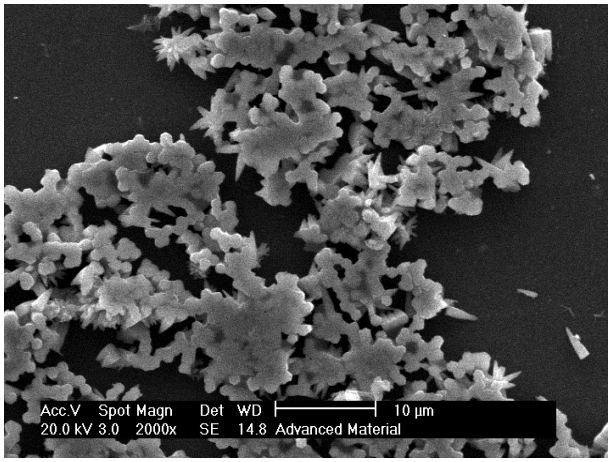

Figure 1: Scanning electron microscopy of ZnO/glass thin film by CBD method

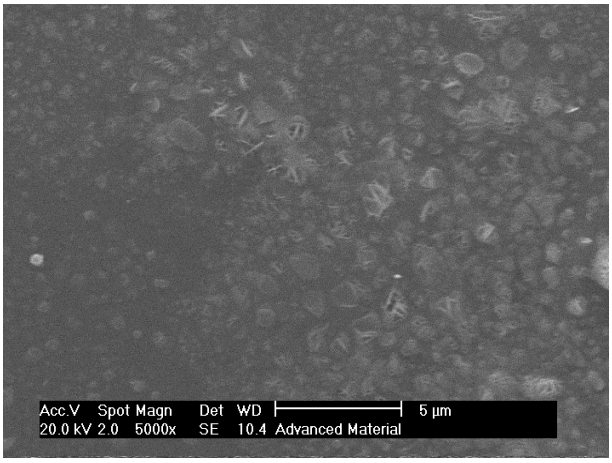

Figure 2: Scanning electron microscopy of Al doped ZnO (0.9 concentration) thin film by CBD method

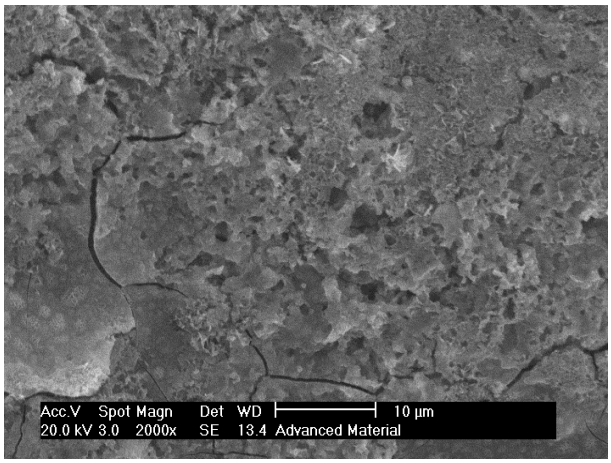

Figure 3: Scanning electron microscopy of Al doped ZnO (1 concentration) thin film by CBD method

Figure4 shows the XRD pattern of AZO thin layers produced by CBD method, a) ZnO layers, b) Al doped ZnO (0.9 concentration), c) Al doped ZnO (1 concentration). As it can be seenin ZnO thin

layersthe preferred orientation of the film is the (002) (figure 4a). By doping Al impurity with Ion concentration ratio of $[Al^{+}/Zn^{+}]$ =0.9 to ZnO layer, layers goes to be amorphous (Figure 4b). In Figure 4c, the density of Al impurity increases to Ion concentration ratio of $[Al^{+}/Zn^{+}]$ =1 and as it can be seen orientation of the film is the (002) but shifting along the 2ɵ axis and its intensities decreased.

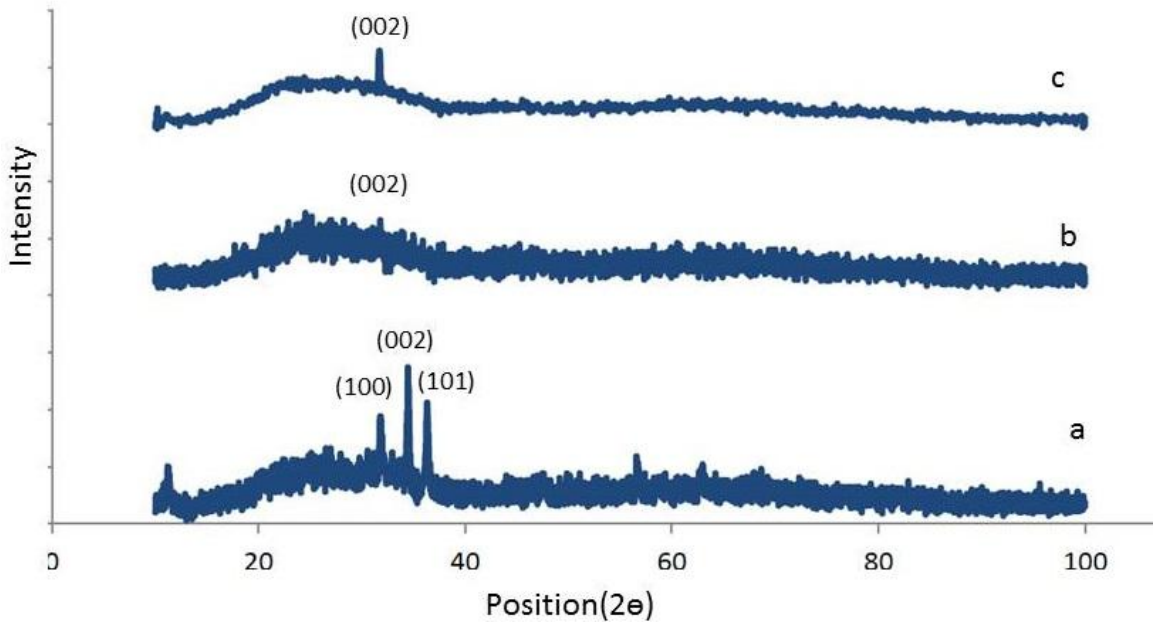

Figure 4: XRD pattern of AZO thin layers produced by CBD method, a) ZnO layers, b) Al doped ZnO(0.9 concentration), c) Al doped ZnO (1 concentration)

Conclusions

Al-doped ZnO thin films were deposited on glass substrates by chemical bath deposition technique. The effects of the doping concentration on the structural properties of ZnO films were studied. Crystalline structures were investigated by XRD and SEM analysis. By doping Al impurity to ZnO layers grains of AZO growth with cubic structure and crystalline intensities decreased.

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