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RESEARCH ARTICLE

Preparation and Properties of Chemical spray deposited in doped ZnO Thin Films

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ABSTRACT

In doped ZnO thin films with different In content were deposited on glass substrates at 400 °C by spray pyrolysis technique. The effect of Indium doping on the structural and optical properties of ZnO films was investigated. X-ray diffraction has shown that the films are polycrystalline and textured with the c-axis of the wurtzite structure along (101). Scanning electron microscopy has shown that the surfaces of the films are homogeneous.

Keywords Zinc oxide, Thin films, Chemical spray, XRD

INTRODUCTION

Zinc oxide in thin film form has gained a renewed interest in scientific and technological research due to the enhanced properties reported recently, which in turn not only increases the performance in the devices that it is involved, but also opens the possibility to contribute in some other promissory applications [1-3]. Zinc oxide is a multifunctional material, which has widely been used for sensors, light emitters and other electronics. As a wide band gap material (Eg=3.3 eV) and due to its low material costs ZnO is one of the most attractive Transparent Conductive Oxides [4-7].

There are several deposition techniques that have been employed to grow undoped and doped ZnO thin films like chemical vapor deposition (CVD) [8-10], magnetron sputtering [11], pulsed laser deposition (PLD) [12], sol–gel process [13] and spray pyrolysis (SP) [14-15].

METHODOLOGY

In-ZnO thin films were deposited on the pre-heated glass substrates by simple and cost effective spray pyrolysis technique at 450 ^{0}C, Spray rate 2.5 ml/min, substrate to nozzle distane 30 cm and molar concentration was 0.5 M. The precursor used was Zinc acetate dehydrated ($Zn(C_2H_3O_2)_2.2H_2O$). The Indium chloride was the doping source. The In /Zn ratio in the solution was varied from 1 at% to 4 at% in the starting solution. The prepared solution is then sprayed on the heated glass substrates which transforms the solution (mixture) to a stream formed with uniform and fine droplets. Characterization techniques used, were XRD, SEM and optical studies.

RESULTS

X-ray diffraction analysis

X-ray diffraction data was analyzed in order to identify the crystal structure and also the various phases present in the samples. Fig. 1 shows the typical XRD pattern of In-doped (3%) film. As seen in Fig. 1, IZO films have polycrystalline nature with a wurtzite structure. The films exhibit a dominant peak corresponding to the (101) plane of ZnO. Other peaks corresponding to (100) and (002) planes are also presents in the spectra indicating polycrystalline nature. It is observed from XRD spectra that the preferential (101) peak intensity increases with increasing in dopant concentration.

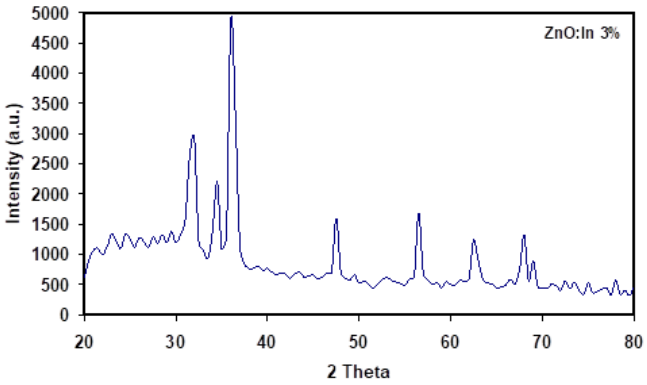

Fig. 1 Typical XRD pattern of In-doped (3%) film.

Surface morphological studies

The two dimensional surface morphologies of IZO thin films deposited at 400 ^{0}C were carried out using SEM images and are shown in Fig. 2. From the micrographs, it is seen that the film consists of grains with uniform coverage of the substrate surface and the grain size is increased from 180 nm to 310 nm as In concentration increased from 1 at% to 3 at%. The crystallite size (grain) calculated from SEM analysis is not in agreement with that of crystallite size calculated from XRD analysis. This may be due to the agglomeration of two or more crystallites to form a cluster.

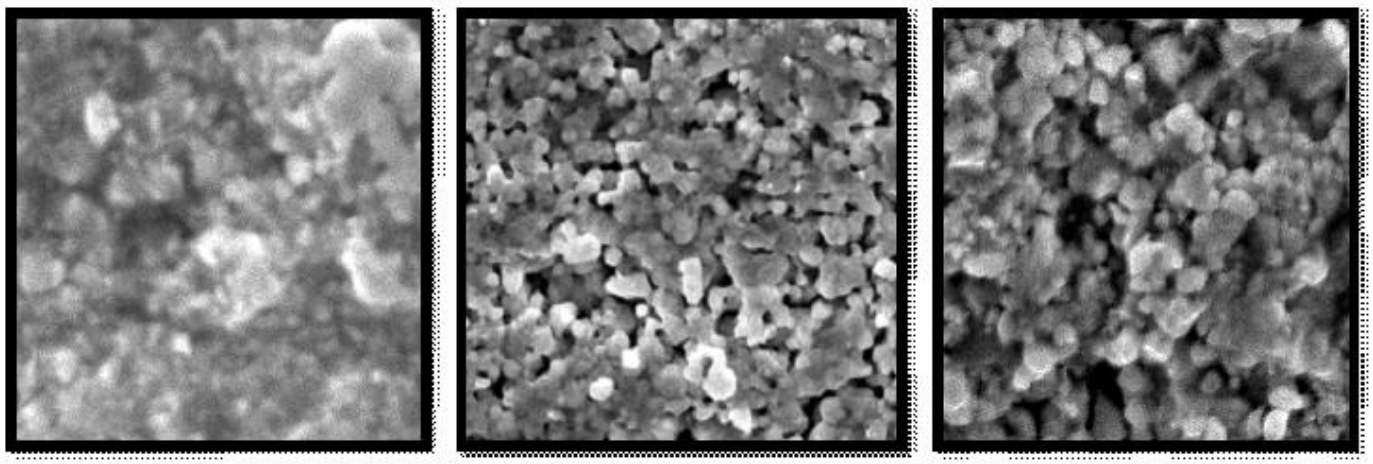

Fig. 2. SEM images

CONCLUSION

In-doped ZnO (IZO) films were deposited on amorphous glass substrates at 400 ^{o}C by spray pyrolysis. The physical properties of these films have been studied in detail as a function of increasing In doping (from 1 to 4.%) concentration. The XRD analysis showed that IZO films possess polycrystalline hexagonal wurtzite structure with a preferred orientation along the (101) direction.

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