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ZINC OXIDE THIN FILMS DEPOSITED BY SPRAY PYROLYSIS TECHNIQUE : EFFECT OF THE SUBSTRATE TEMPERATURE ON THE PHYSICAL PROPERTIES

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ABSTRACT

In this paper, ZnO films were deposited by spray pyrolysis. This deposition technique presents interesting advantages: the low substrate temperature, the good adhesion of the films on the substrates, and a high deposition rate. Moreover, this is relatively a cheap deposition method. The physical properties of the films depend on the spray parameters, such as substrate temperature, concentration, spraying time and substrate-target distance [1]. During spray pyrolysis process, when aerosol droplets arrive close to the preheated substrates, the droplets undergo thermal decomposition, which results into the highly adherent zinc oxide film for formation. During the pyrolytic process, following reaction takes place :

$$Zn(CH_3COO)_2 + 2CH_3OH \xrightarrow{425°C} ZnO + (CH_3COCH_3) + H_2\uparrow + O_2\uparrow$$

The as-deposited films were transparent and well adherent to the glass substrates. Film thickness was determined by using weight difference technique.

Keywords: ZnO thin film, spray pyrolysis, substrate temperature, physical properties.

INTRODUCTION

ZnO transparent conducting films possess very interesting properties in the electrical and optical application fields [2]. They have low electric resistance and high transparency in the visible wavelength range [3]. The material is composed of cheap and abundant elements, and is readily produced for large-scale coatings. These films have attracted interest in many applications such as solar cells [4], gas and optical sensors [5], ultrasonic oscillators [6], transducers [7], optical waveguides and photoprotective coatings [8]. Various deposition techniques can be used to prepare ZnO thin films, such as reactive and ion-assisted evaporation, laser ablation, sol-gel processing, chemical vapour deposition, sputtering and spray pyrolysis. This last technique is based on the pyrolytic decomposition of small droplets of a zinc-containing solution onto a heated substrate, under atmospheric conditions.

RESULTS AND CONCLUSIONS

In our work, Zinc oxide (ZnO) transparent thin films have been deposited on soda-lime glass substrates by a pneumatic spray pyrolysis technique. The effect of the substrate temperature on the electrical, morphology and optical characteristics of ZnO thin films was studied. Surface investigations such as AFM, SEM and XRD patterns of the films were investigated. It

was found that, as the substrate temperature increases, the electrical resistivity decreases, reaching a minimum value in the order of 7.3×10^{-3} Ω·cm, at 415 °C. Further increase in the substrate temperature results on an increment on the electrical resistivity of the thin solid films. All the samples were polycrystalline with a well-defined wurtzite structure.

The effect of substrate temperature on structural, electrical and optical properties was studied. It is found that these properties depend on substrate temperature and spraying solution concentration and can be tailored in view of desired application. All the peaks of the ZnO thin films correspond to the peaks of standard ZnO (JCPDS S6-314). For all the samples, (100), (101) and (002) diffraction peaks are observed in the XRD pattern, showing the growth of ZnO crystallites along different directions. The preferred growth shows a switching from a random orientation at low substrates temperatures to (002) in the case of films deposited at the highest substrate temperature used. As the substrate temperature increases, the corresponding surface morphology changes from an almost faceted pyramidal to round-shaped form. The optical transmittance of the films in a interval of 400 to 700 nm is around 70%, with a band gap value in the order of 3.45 eV.

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