Structural studies of tin doped zinc oxide thin film by using x- ray diffraction technique

Gursharan Kaur[1], Muneer Ahmad[2]

[1]School of chemical engineering and physical sciences, Lovey Professional University, Phagwara, Punjab

[2]School of computer science and engineering, Lovey Professional University, Phagwara, Punjab

Abstract:

Tin doping is done in zinc oxide thin films which were deposited onto glass substrates by using spin coating method. The deposited film is annealed at 200 ^{0}C temperature before subjected for characterization. The crystallinity and defects are studied using Panalytical X' pert Pro XRD. Average crystallite size is lies in range 285- 900 Å.

Keywords: X ray diffraction, Thin films, Sol-gel method, Crystallographic parameters,

Introduction:

Zinc oxide thin films have got worldwide importance in the scientific community because of their range of applications in various fields [1-3]. The importance of synthesis of new materials for industry has resulted in a tremendous increase of innovative thin film processing technologies [4-6]. ZnO has wide band gap and is a promising candidate for application in photovoltaic devices and optical electrical devices such as thin films solar cell [7-10]. In the present work, tin doped thin film of ZnO is synthesized with the help of spin coater. X-ray diffractograms are taken using Panalytical X' pert Pro XRD and the average crystallite size is lies in range 285- 900 Å. It is found from XRD analysis that the intensity reduces which leads crystallinity.

Experimental methods:

As a starting material, Zinc acetate dihydrate (Zn $(CH_3COO)_2$. $2H_2O$), Tin tetrachloride ($SnCl_4$), 2-Methoxyethanol, Monoethanolamine chemicals and alkali free glass slides are used as substrates. After cleansing the substrate ultrasonically in acetone for 20 minutes. They are further washed with deionised water for 20 minutes and finally dried in atmosphere. For the preparation of ZnO films, zinc acetate dihydrate [Zn $(CH_3COO)_2$. $2H_2O$] was dissolved in 2 – methoxyethanol and the solution at 60 ˚C on hot plate was heated with magnetic stirring for 2 hour. After one hour add an optimized amount of mono-ethanolamine (as a stabilizer) to the solution to make the solution clear, transparent and homogenous. Properly cleaned glass plates are used as substrates. The solution was dropped on the glass substrate at the speed 3000 rotations per minute for 30 secs. Characterisation method used to analyse thin films is XRD

(PANalytical, Xpert – Pro with copper K radiation).

Results and discussion

X-ray diffraction technique is tried to recognize the specimen's crystalline phases and to measure its crystallographic parameters. Diffraction peak positions are accurately measured with XRD, which makes it the best method for characterizing homogeneous and inhomogeneous strains [11-12].

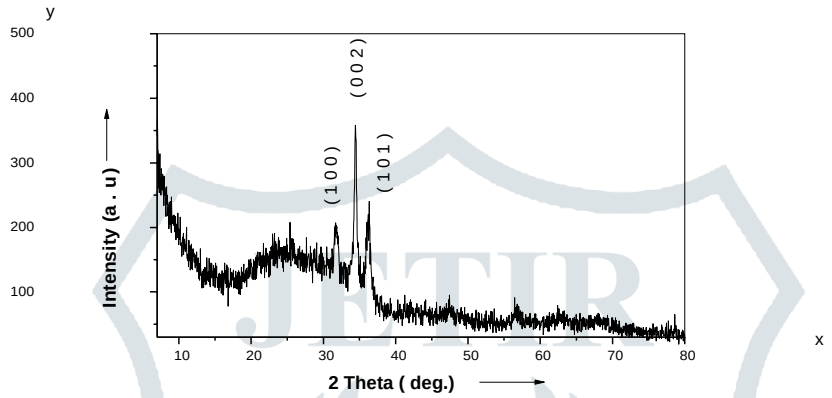

Fig 4.2: The XRD pattern for 2 mol% Sn doped ZnO (ZS2) thin film.

Figure 1 shows x-ray diffraction pattern of the Sn doped thin film (2 mol %) of ZnO synthesised at a substrate temperature of 500 ˚C. From XRD analysis, three peaks were observed out of which one is the strongest intensity and the corresponding planes are mention in the figure 1. According to JCPDS card no.89 - 0510, there is peak corresponding to d-value 2.6027 Å have the strongest intensity. The other peaks at d- value 2.8204 Å and 2.4786 Å corresponds to planes (1 0 0), (0 0 2), (1 0 1) according to the JCPDS card no. 79 – 0207 and 80 - 0075. The strongest peak has grain size 83 nm while the average grain size of the prepared sample is 51 nm. Shifting of peaks towards higher angle is observed, as shown in table 1.

Pos(˚2 TH)	FWHM (˚2TH)	d-spacing (Å)	Grain Size (nm)	Plane (h k l)	Int – f	Relative Intensity (%)
31.7286	0.5510	2.8204	35	1 0 0	570	10.23
34.4570	0.2362	2.6027	83	0 0 2	414	33.94
36.254	0.5510	2.4786	36	1 0 1	999	15.77

Table 1: The values of d spacing, Grain size, Plane (h, k, l) and intensities for 2 mol % Sn doped ZnO (ZS2) sample.

Conclusion:

The crystallographic parameters of Sn doped ZnO thins films were calculated and analysed using X ray diffraction spectrum. Average crystallite size lies in range 51-83 nm. It is concluded from XRD analysis that the intensity reduces which leads to crystallinity.

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