Optical Properties of ZnO Thin Film Deposited by Spray Pyrolysis

[1]Sachin H. Dhawankar, [2]Avish K. Patil, [3]B.M.Suryavanshi

[1]Department of physics, Chhatrapati Shivaji Institute of Tech., Durg(C.G), India
[2,3]Department of physics, Institute of science, Nagpur -4400001,(M.S),India
Email:- sachindhawankar@gmail.com

Abstract- Zinc oxide (ZnO) transparent thin film is deposited on glass subtract at 390^{0}C by spray Pyrolysis technique using aqueous solution of Zinc acetate and hydrogen peroxide. The optical properties of grown ZnO thin film are present. Optical properties of ZnO thin film is studied using UV- VISIBLE Spectrophotometer. Optical absorption measurement are carried out in the visible region (380 – 10000nm) and optical energy band gap is values are calculated

Keyword: - ZnO thin film, spray pyrolysis, optical properties, Optical band gap.

I. INTRODUCTION

Metal and non metal compounds are studied in the thin film[1-5] .Zinc oxide (ZnO) is transparent conducting oxide, high optical transparency in the visible region and near – infrared region([9]). ZnO thin films are promising material for various applications for electronic and optoelectronic application such as transparent electrodes, solar cell, liquid crystal displays, gas sensors etc. [6] . The Zinc oxides from group II – VI are explored in determines of thin films devices. Various techniques have been used for depositing ZnO thin films, are available in literature such as sputtering, sol – gel method, chemical bath deposition, spray pyrolysis.

In this article we studied the optical characterization of ZnO thin films were prepared using spray pyrolysis technique by using UV- VIS spectrometer from its absorption spectrum in optical range (380 – 1000nm).

II. EXPERIMENTAL STUDY

Glass slide is used as a Glass substrate to deposited ZnO thin film, which was cleaned in conc. Nitrate acid, alcohol and distilled water for several times to remove the impurities on the surface of substrate before the deposition.

Zinc Acetate is stirrer for 6-7 hours and the solution stirrer 10 min on electronic stirrer. Zinc

Acetate (MW 219.49 gm/cc) (0.1N) solution was prepared in double distilled water and Conc. hydrogen peroxide 3.4 cc (MW 34.01 gm/cc) was mixed together with cadmium chloride precursor in the sprayer.

The weight of the glass substrate before spraying & after spraying was measured using electron unipan microbalance of accuracy 10^{-4} gm.

The clean dielectric substrate was arranged on hot metal plate on heating coil with controlled variac. This glass substrate is heated at constant suitable temperature (390^{0}c). The solution sprayed on the glass slide was to form ZnO thin film on the substrate with high pressure through a fine sprayer bore. After the solution finished the substrate was allow to cool up to room temperature. The ZnO thin film is then used to study optical properties and energy gap measurement.[8] .

After preparation the ZnO thin films by spray pyrolysis technique the optical absorption & percentage transmission were measured by UV – VIS Spectrophotometer Elco (SL- 159) in the wavelength range 380 – 1000 nm.

III. RESULT AND DISCUSSION

The nature of the deposited thin film was characterized by XRD pattern (fig. 3). The nature of ZnO film is amporous.

To determine the band gap of the thin film the equation of stern [6, 8] was used.

$$A = \frac{\left(K(h\nu - Eg)^{\frac{n}{2}}\right)}{h\nu}$$

$$A.h\nu = \left(K(h\nu - Eg)^{\frac{n}{2}}\right)$$

$$(A.h\nu)^2 = K(h\nu - Eg)^n$$

Where ν = the frequency of radiation, h = Planck's constant, K = constant, n =1 for direct band gap material.

A plot of $(A.h\nu)^2$ vs. hν is plotted (fig. 2). The absorption coefficient $(A.h\nu)^2$ is linear function of frequency ν. This indicates that the transition is direct transition in

ZnO material. Hence, a straight line tangent to a linear portion of $(A.hv)^2$ cut hν axis which gives the band gap energy of grown ZnS film in the present study.

Optical absorption & % transmission of the deposited ZnO thin film were obtained in the visible region (380 – 1000nm) on ELCO – SL -159 Spectrophotometer

Transmittance and absorption as function of wavelength are shown in figure 1 which shows high transmission in the visible wavelength.

In figure 2 the plot of $(Ahν)^2$ verses photon energy (hν) for ZnO thin film shows straight line extrapolation (linear function of frequency(hν)) at strong absorption edge.

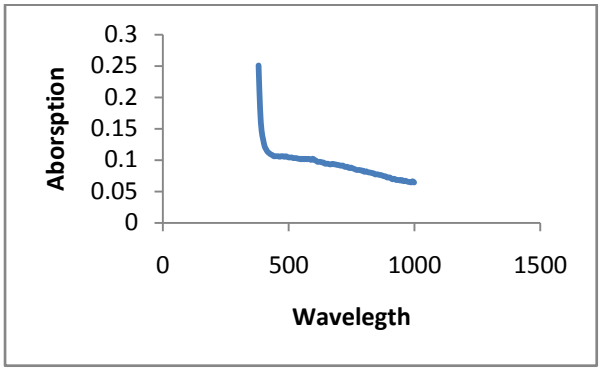

Fig 1 (a) absorption (A) vs Wavelength (λ)

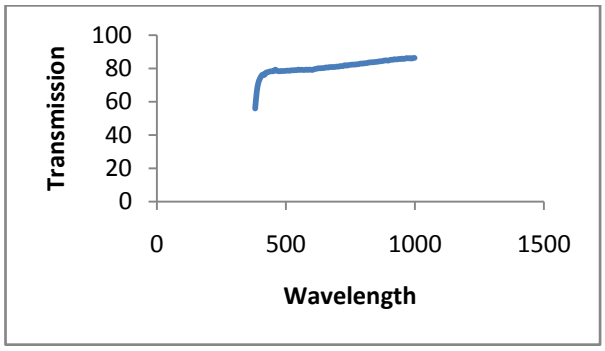

Fig 1 (b) Transmission vs Wavelength (λ)

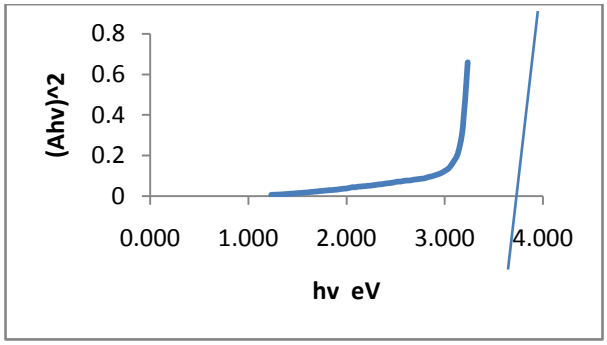

Fig 2. $(Ahν)^2$ vs hν (eV)

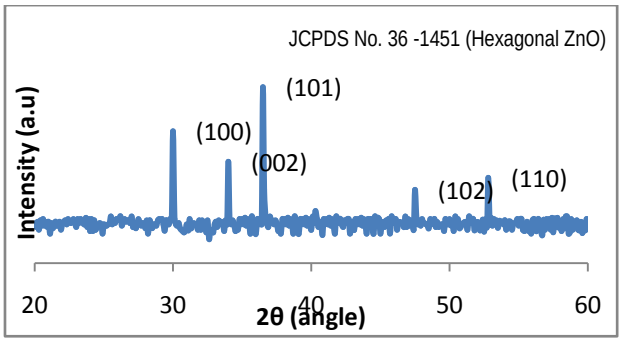

Fig.3. XRD Pattern of ZnO

CONCULSION

Fig 3 shows the X – ray diffraction pattern of ZnO thin film deposited at 390^0. As the grow XRD pattern of ZnO sample shows that the film peaks at 30.54^0, 34.12^0, 36.50^0,47.66^0,52.83^0 with there reflection from (100), (002), (101), (102), (110) hexagonal ZnO (JCPDS card no. 36- 1451). The energy band gap obtained in this work is Eg = 3.15 ev. Optical analysis show that sprays pyrolysis technique is useful method for the deposition of ZnO Thin films.

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