International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 9
September 2017

Simple Spray Pyrolysis Deposition of SnO_2 thin Films and their Structural, Morphological and Optical Characterization

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Abstract:- *Tin oxide is most important metal oxides due to its applications from electrochemistry to optics, solar cells or gas sensor. We obtain structural transparent and conducting, adherent SnO_2 thin films by spray pyrolysis technique and the films were characterized by XRD, SEM and UV-Vis spectroscopy. XRD analysis of nanocrystals shows the crystalline nature. The parameters such as crystalline size have been analyzed. The images of SnO2 nanoparticles showed their morphology, particle size and crystalline respectively.*

Keywords:- Spray pyrolysis thin films, SEM, XRD and optical parameters.

Introduction:- In recent years, there has been considerable interest in use of thin flms in solar cell devices.SnO_2 is a semiconductor with an energy band gap of 2.7 eV and the electrical properties can be suitably controlled by an altering the deposition conditions.

These materials are important in the fields of electronics, photograph, data storage, optoelectronics, biological labeling, catalysis, imaging and biosensing. SnO_2 can be prepared by different techniques such as Spray pyrolysis, electro deposition, RF sputtering, chemical bath deposition method.

In this paper SnO_2 material is fabricated by spray pyrolysis method, the purpose of this work was to investigate the effects of the growth condition for various temperature from 200^0 C to 400^0 C.

Experimental Work:-

The source material we have used was $SnCl_2$ (Merk Chemical product 99% purity). The precursor solution is prepared in water with addition of concentrated HCl with constant stirring to get required pH of the solution. After preparation of precursor solution deposition was carried out on heated glass substrate using direct spray pyrolysis technique.

As spray pyrolysis process consist of various process parameters such as concentration of precursor, solution volume, air-flow rate and substrate temperature. Keeping aim in mind with several depositions for obtaining transparent and conducting films film formation was carried out with constant air-flow rate of 7 lpm, 0.5m concentration of precursor with 50ml solution quantity. The deposition was carried out for various substrate temperatures and varied from 2000 C to 4000C temperature.

In spray pyrolysis thin films of SnO_2 prepared by the reaction

$SnCl_4+2H_2O$ ------→SnO_2+4HCl

Table 1.

Sr.No.	Molarity	Quantity of Solution	Spray rate	Temperature of substrate	Thickness shown by film
1	0.5 M	50 ml	7 lpm	200^0C	11.6 nm
2	0.5 M	50 ml	7 lpm	250^0C	11.7 nm
3	0.5 M	50 ml	7 lpm	300^0C	13.7 nm
4	0.5 M	50 ml	7 lpm	350^0C	14.7 nm
5	0.5 M	50 ml	7 lpm	400^0C	17.0 nm

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RESULTS AND DISCUSSION:-

SnO_2 thin films were deposited by the spray pyr olysis technique. The transparency of thin films so formed depends on parameters like substrate temperature and concentration of the precursor solution. Also other parameters such as spray duration, flow rate, pressure etc.

Result analysis

XRD:-

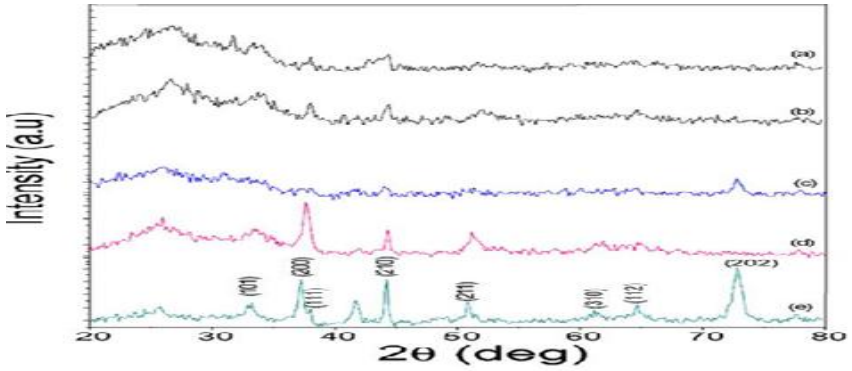

Fig 1: X- ray diffraction analysis of temperature dependent SnO2 thin films (a)200°C (b)250°C (c) 300°C (d)350°C (e) 400°C.

Fig.1 shows the X-ray diffraction pattern for different substrate temperatures. The films grown below 350°C are amorphous in nature and the films grown above 350°Care polycrystalline nature, with [2 0 0] as preferred orientation. Next to this is [2 1 0] peak, other peaks such as [1 0 1], [2 1 1], [2 2 0] and [3 1 0] are also observed at relatively low intensity.

As the substrate temperature increases the crystalline of the films improves. The XRD patterns were indexed on the basis of a tetragonal structure with the lattice parameters a =4.804Å and c = 3.079 Å.

SEM:

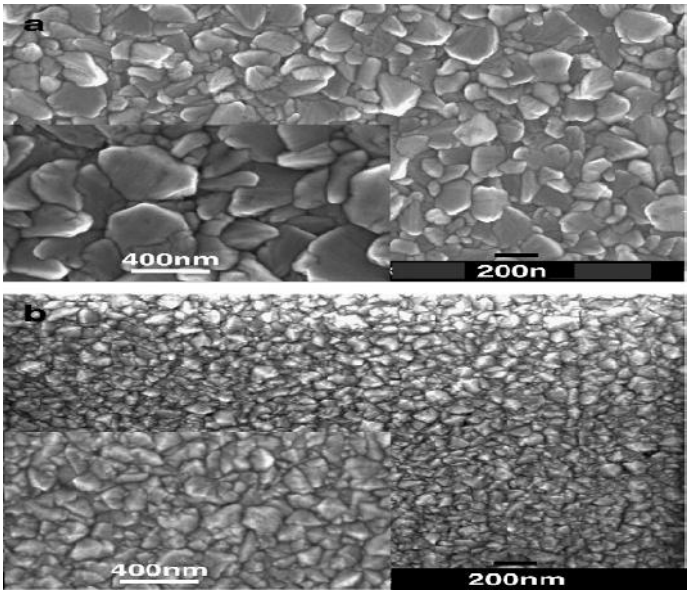

Fig 2: shows the SEM micrographs for two films in a) the SnO_2 film deposited at lower substrate temperature (200°C) and b) the SnO_2 with the highest substrate temperature 400°C. It is seen that the grain size in the film of low substrate temperature sample varies between 50

and 200 nm with an average size around 100 nm, whereas in the sample deposited at 400°C shoes grain size is much more uniform, with a smaller average size of approximately 50 nm. In order to visualize more details in the microstructure, i.e., shape and size of grains, a higher magnification image of a selected area, are included at the left lower corner of Fig2 a and b.

UV visible spectroscopy:

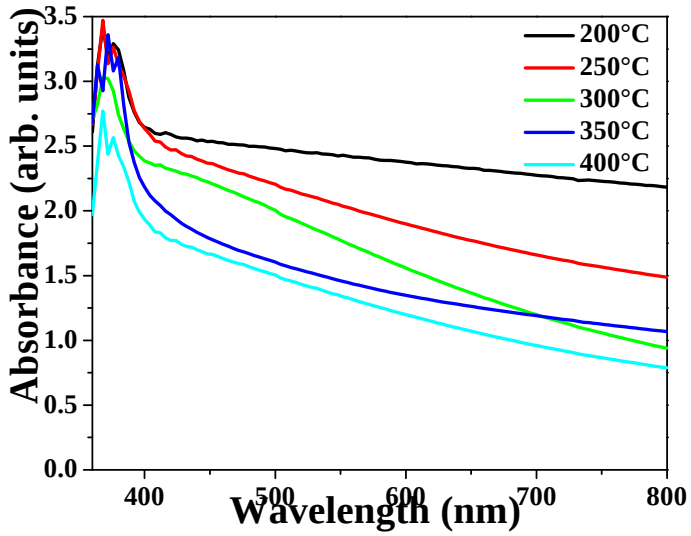

Fig 3: UV Visible Spectra

The variation of absorbance (αt) of SnO_2 film with the substrate temperature is shown in Fig. This spectrum reveals that as prepared SnO2 film has low absorbance in the visible region, which is a characteristic of SnO_2. The absorbance has decreased after heat treatment to SnO_2 film. The absorption edge shift of thin film materials is attributed to various factors such as doping, electronic defects and nanorods imbedded in the amorphous phase. When a metal nanoclustor was embedded in the dielectric matrices, an optical absorption spectrum was observed which accounts for the quantum size effect**.**

Conclusion:

In this study, the influence of the substrate temperature on the structural, morphological and optical, properties of SnO_2 thin films grown on glass substrates by spray pyrolysis method was investigated. The XRD studies show that the films deposited at low temperature (623K) have amorphous in nature while the crystllanity increases with increase in substrate temperature.

The surface morphology using SEM analysis shows films are uniformly grown decrease in grain size as substrate temperature increases. The absorption spectra reveal that the films posses low absorption with increase in substrate temperature and have sharp absorption edge at low wavelength. Thus the results shows that use of spray pyrolysis grown SnO_2 thin films subjected to variation in temperature as thin-film varistors in electronic industry.

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