STUDY OF OPTICAL AND STRUCTURAL PROPERTIES OF SnO_2 THIN FILMS GROWN ON GLASS SUBSTRATE BY CHEMICAL BATH DEPOSITION TECHNIQUE

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Abstract: Thin films of tin oxide (SnO_2) have been deposited on a glass substrate using simple chemical bath deposition technique for solar cell application. Film deposited on a glass substrate using the tin precursor is as tin chloride dehydrates and sodium hydroxide. Optimization of molar concentration, temperature of bath, duration of deposition time and pH of the solution to achieved uniform deposition and high quality thin film. The compositional, morphological, structural and optical analysis of the samples was characterized by XRD, EDAX, FE-SEM and UV-Visible spectroscopy.

Key-words: **CBD, Thin Film, characterization etc.**

I. INTRODUCTION

Transparent conductive oxide materials have attracted significant interest due to their prospective applications in electro-optic electrochemical devices [1]. Tin oxide (SnO_2) is a wide band gap (3.6eV) semiconductor with a large electronic binding energy of 130 mV [2].It has characteristics such as high transmittance in the ultraviolet-visible region and high reflectance in infrared region, high electrical conductivity, high melting point, metal-like conductivity, absence of toxicity, easy doping, easy tailoring and abundance in nature [3]. Electrical and optical properties of SnO_2 thin films make them a very suitable candidate for usage in optoelectronic devices and solar cell applications [4].SnO_2 was intensively used gas sensor because it has high reactivity easily adsorption, low temperature process, good stability and low cost production [5].

Several deposition techniques such as, Modified Successive Ionic Layer Adsorption and Reaction (M-SILAR), Hydrothermal process, Spray Pyrolysis, Metal Organic Chemical Vapor Deposition , Pulsed Electron Beam Deposition , Pulsed Laser Deposition , Sol-gel , Vacuum Evaporation . [6-12]. The chemical bath deposition technique for the preparation of SnO_2 thin films has many advantages including low cost, easy operation, simple to operate, low energy consumption, mass production, large area of deposition on the substrate [13-15]. However, very few attempts to grow SnO_2 thin films using CBD have been reported [16].

In the present investigation we deposit tin oxide (SnO_2) thin film gown on glass substrate by a simple chemical bath deposition technique at low temperature and optical , structure properties were studied.

2. EXPERIMENTAL DETAILS

The glass substrates of dimensions 75 mm × 25 mm × 1.10 mm was used for deposition of SnO_2 thin film by chemical bath deposition technique. Substrates were washed with double distilled water and boiled in chromic acid for 2 h. Further, they were washed with detergent and rinsed in acetone with ultrasonic treatment followed by drying in hot air in closed vessel. The reaction bath was composed of aqueous solutions of1M stannous chloride dehydrate ($SnCl_2.2H_2O$),1M of NaOH and NH_4OH is used is used as complexing agent . All chemicals are used without any further purification. Firstly, 5 ml of deionized water was poured in to 50 ml of beaker and 1.125g of stannous chloride added to the deionized water. Few drops of concentrated hydrochloric acid were added drop by drop to the solution in order to obtain clear solution. Then 1 ml of 1M sodium hydroxide and 40 ml PVA solution were added to the Sn precursor solution. Diluted ammonia solution was added until the pH of the solution was 9. Finally distilled water added to make a total of 50 ml volume . The temperature of bath maintained at 60^0C. Pre-cleaned glass substrates were inserted vertically in the bath. The deposition time was carried out for 60 minutes. Obtained SnO_2thin films were rinsed by deionized water and dried in air.

3. RESULT AND DISCUSSION

The optical and structure properties of prepared thin film can be investigated by different characterization technique such as, surface morphology by scanning electron microscope (SEM), optical studies by UV-Vis spectrophotometer. The structural properties of the experimental films were analyzed using X-ray diffraction data. The elementary analysis study analyzed by energy dispersive X-ray analysis (EDAX) technique.

3.1 STRUCTURE ANALYSIS

The structure property of SnO_2 thin film was analyzed using X-ray diffraction data. Figure 1 shows the XRD spectra of SnO_2 thin film indicated (110) plane at $2\theta= 26.80^{O}$ as the preferred orientation. Other peaks are such as (210) and (211) of SnO_2appeared. The size of nano-crystallites L can be calculated using Scherrer'sformula

$$L = K \lambda / \beta \cos\theta$$

Where L is the coherence length,

K is a constant representing particle shape factor (0.94),

λ is the wavelength of the X-rays (1.54060 Å),

β is the FWHM of the peak and θ is the corresponding diffraction angle.

Then the diameter D of the nano-crystallite is given by

$$D= 4L/3$$

The particle size is calculated using (110) peak as it is the predominant orientation observed for SnO_2 films and the evaluated particle size was 1.11 nm.

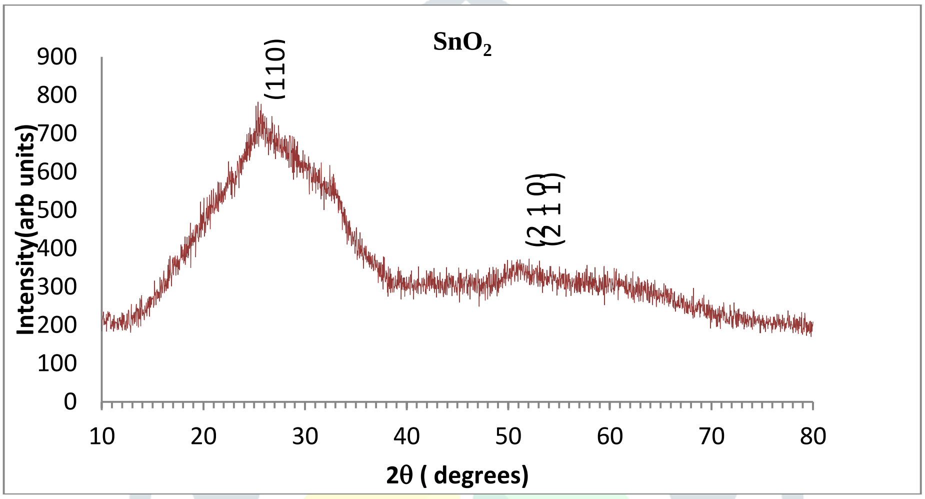

Figure 1: .X-ray diffraction spectra of SnO_2 film

3.2. SURFACE MORPHOLOGY

Figure 2shows the scanning electron microscopy (SEM) image of as grown SnO_2 thin film surface. The film of SnO_2 is uniformly distributed on glass substrate and well covered with the deposited material without cracks and pinholes. The field emission scanning electron microscopy (FE-SEM) study for SnO_2 films on the glass substrate reveals that the film formed is uniform and homogenous.

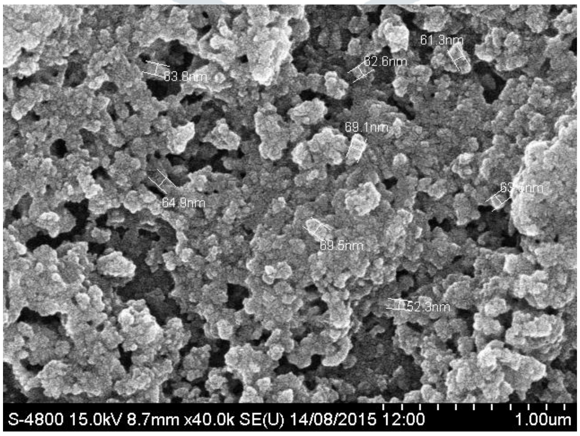

Figure 2 : SEM micrograph of as grown SnO_2thin film

3.3. EDAX

The elemental analysis of the SnO_2 thin films deposited on glass substrate was investigated by energy dispersive X-ray analysis (EDAX) technique. A typical EDAX patterns are shown in fig. 3. The analysis confirms the presence of Sn and O in the deposited film and shows that film is mostly stoichiometric.

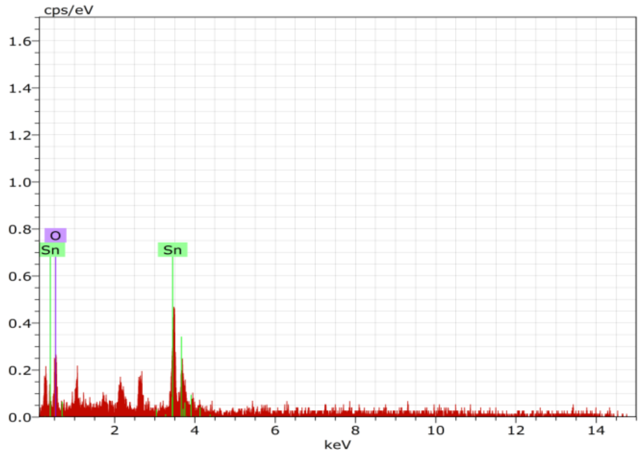

Figure 3: EDAX spectra of SnO_2Thin films

3.4. ABSORBANCE:

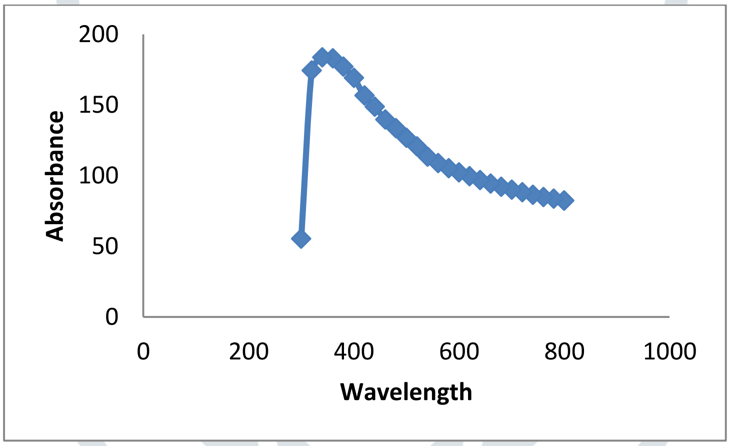

Figure 4: Absorbance spectra of SnO_2 thin film.

The optical property of SnO_2 thin film deposited on glass substrate was studied using the absorbance spectra obtained by spectrophotometer. The absorption spectra of chemical bath deposition thin film are shown in figure 4. In this film, the strong absorption is in the wavelength range of 390nm. Absorbance is most important property of SnO_2thin film to be considered for solar cell application.

4. CONCLUSION:

The SnO_2thin film was successfully deposited by chemical bath deposition technique. Strong absorption is obtained in the wavelength range of 390 nm.

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