ISSN: 0971-1260
Vol-22-Issue-16-August-2019

Optical Band Gap Studies of Sn Doped Sol-Gel Prepared Zinc Oxide Thin Film

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Abstract:

Thin films of Sn doped ZnO were placedon glass substrates by using spin coating method. The effect of Sn doping on optical properties of ZnOis studied withmol percentages of dopant in ZnO as 0, 2, 4, 6, and 8%. The optical spectra observed in the range 200 – 800 nm shows a very good transmittance above 90%. The band gap variation on Sn doping lies in the range 3.23 – 3.27 eV. The increase in band gap is good sign that these films can be used as coating in soar cells.

Keywords: Thin films, Sol-gel method, Optical properties, UV- Visible spectra

1. Introduction:

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 [1-4]. By heavily substitutional doping, ZnOs charge carriers could be increased upto 2×10^{21} cm^{-3}. This means ZnOs conductivity could vary from very low (insulator) to moderately high (semiconductor) to high (conductor) and can be an excellent candidate for transparent electrodes in flat panel displays and solar cells [5-8].

In the present work, thin films of ZnO were synthesized with the help of spin coater.The change of Sn doping on optical properties ZnO is studied withmol percentages of Sn as 0, 2, 4, 6, and 8%.The optical study of band gap is explored using UV-visible 1800 spectrophotometer. The band gap of the prepared films is calculated from the UV-visible data for optical applications.The optical spectra

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observed in the range 200 – 800 nm shows a very good transmittance above 90%. The band gap variation on Sn doping lies in the range 3.23 – 3.27 eV.

2. 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. Prior to the deposition of thin films, cleansing of the substrate is done with soap solution involving dipping substrate in soap solution for 10 minutes and then scrubbing the substrate in the soap solution. After this 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 platesare used as substrates. The solution was dropped on the glass substrate at the speed 3000 rotations per minute for 30 secs. UV visible UV-VIS Probe 1800 spectrophotometer (Version 2.33) is used for optical studies.

3. Results and discussion

The optical properties of the films were measured using UV – VIS 1800 spectrophotometer. The optical properties of thin films involve transparency of the thin films i.e absorption and transmission spectra of thin films. Transmission spectra of zinc oxide thin films prepared for different Sn doping concentrations (0 to 8mol%) are shown in figure 1. The measured transmittance of the ZnO and ZnO:Sn films in the rage 200 nm to 800 nm, shows that ZnO film is 81 % and for Sn doped ZnO films the average optical transmittance is 90% ,but optical transmittance is more for 2 mol % doped film than 4 mol%, 6 mol% and 8 mol% doped film. This shows that there is increase of transmittance on Sn doping.

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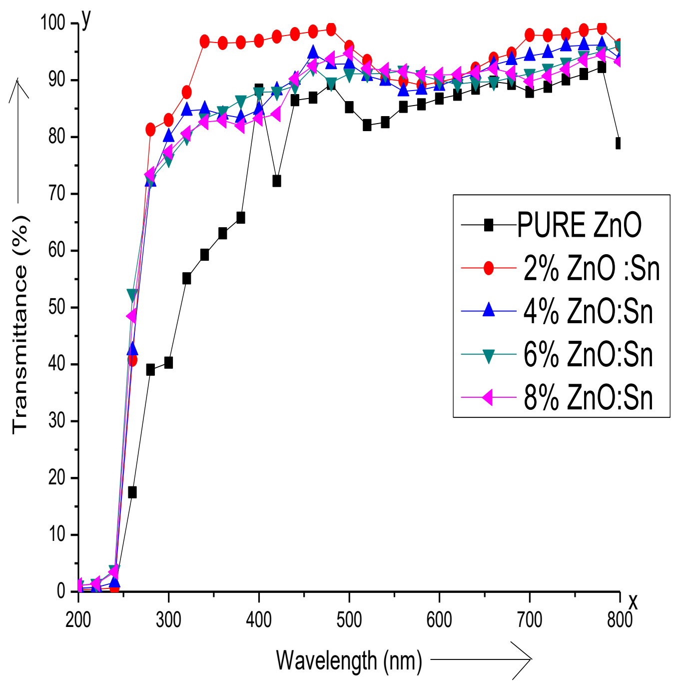

Figure 1. Variation of transmittance (T) for undoped and Sn doped ZnO thin film samples.

To know the band gaps for the prepared fims,Tauc's [9] curve are drawn from the following formula

$$\alpha h \nu = A (h \nu - E_g)^{1/2}$$

Where *A* is a constant, *hν*is the photon energy and $E_g$is the optical bandgap. The plots of in the absorption region are given in figures 2, 3, 4, 5 and 6. As can be observed form the figures 2, 3, 4, 5 and 6, the optical band gaps are 3.24 eV, 3.23eV, 3.26 eV, 3.27 eV and 3.28 eV for ZS0, ZS2, ZS4 and ZS6, ZS8respectively for the prepared films.The optical band gaps of the films increasewith the increase in Sn concentration.The bandgap increases from 3.23 to 3.27 eV as Sn dopant increased but increase is uneven. The increase in band gap is good sign that these films can be used as coating in soar cells.

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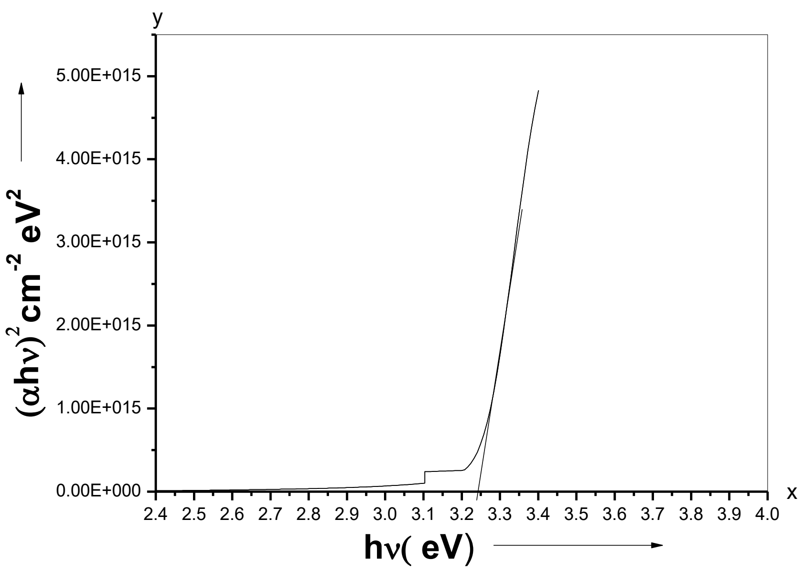

Figure 2. Plot of band gap forundopedZnO (ZS0) thin film.

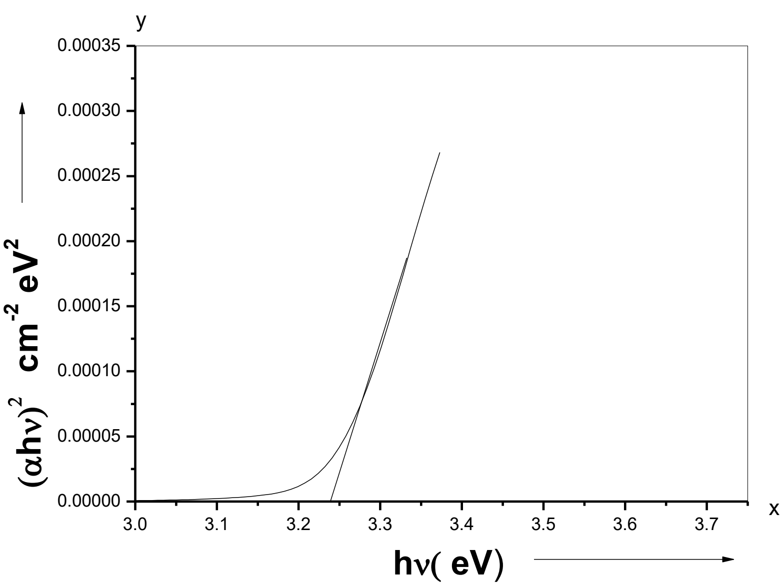

Figure 3. Plot of band gap for 2 mol % Sn doped ZnO (ZS2) thin film

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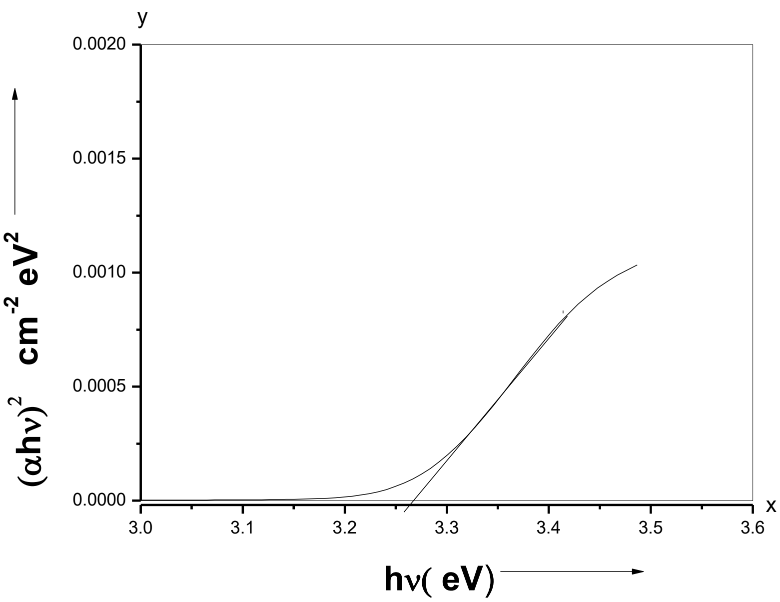

Figure 4. Plot of band gap for 4 mol % Sn doped ZnO (ZS4) thin film

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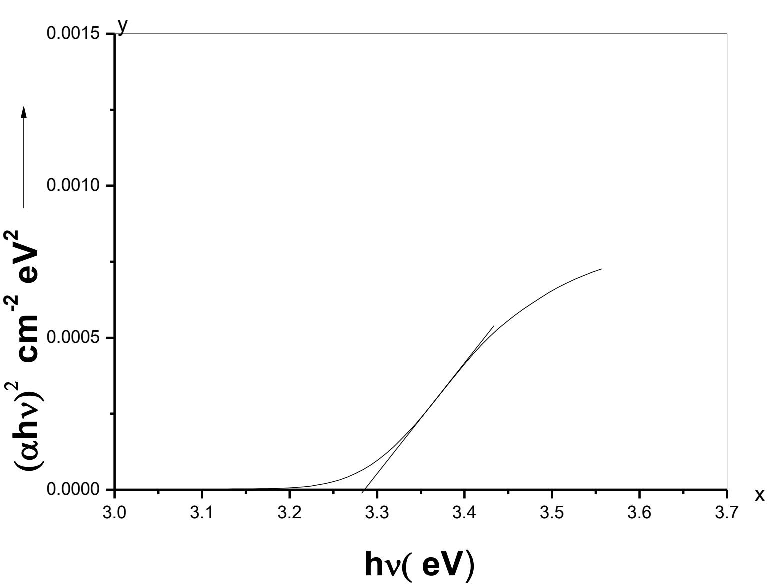

Figure 5. Plot of band gap for 6 mol % Sn doped ZnOthin films

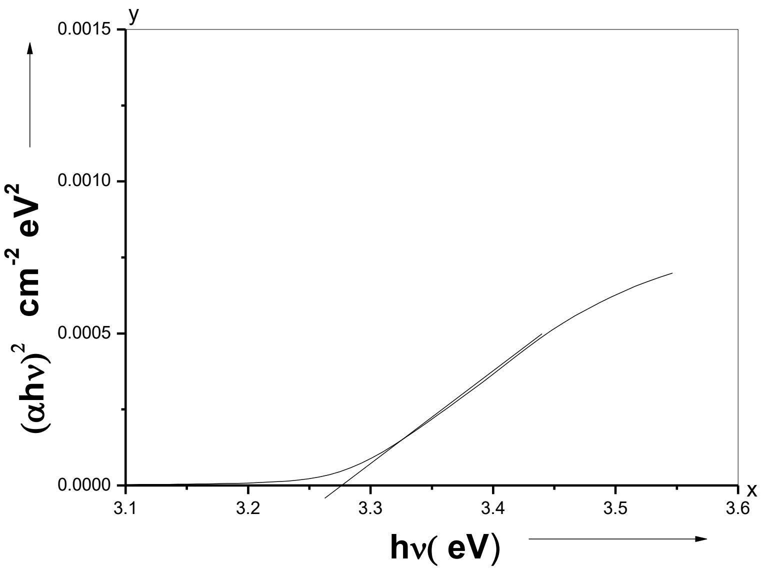

Figure 6. Plot of band gap for 8 mol % Sn doped ZnOthin film

4. Conclusion:

The values of band gap are estimated from the Tauc's plots for sol-gel spin coatedZnO thin films and the bandgap increased from 3.23 to 3.27 eV as Sn dopant increased but increase is uneven. . The increase in band gap is good sign that these films can be used as coating in soar cells.

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