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OPTICAL AND MORPHOLOGICAL STUDIES OF TELLURIUM DOPED ZINC OXIDE IN PHYSICAL VAPOUR DEPOSITION OF NANO COMPOSITE MATERIALS

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Abstract-The Tellurium doped zinc oxide (ZnO:Te) thin films and their squeeze in the structures were prepared onto an FTO substrate by thermal evaporation method under the vacuum of 10-5 Torr. The prepared thin film is characterized for their Scanning Electron Microscope, elemental analysis of EDAX spectrum, DRS UV spectrum and I-V studies. The surface morphology of (ZnO: Te) film at different magnification and fully covered on the FTO substrate. The film exhibit as a smooth plane surface, that the continuous, finely granulated closed formation. Some conglomeration is formed due to the excess of oxygen flow at the time of processing. It appears more uniform spherical grain. The grain size of the film estimated from their SEM image 20 nm. From the EDAX spectra, the element composition of the prepared thin film is evaluated and revealed that the presence of Zn, Te and O elements. The optical parameters are determined from the DRS-UV Spectrum at normal incidence in the wavelength range of 200nm -1100nm. The absorption maximum values of ZnO: Te were found to be 470 nm .The band gap of semiconductors is related to its range of absorption wavelength and the band gap decreases with increasing of absorption edge.The band gap values of ZnO: Te were found to be 3.1eV. The Tellurium doped zinc oxide (ZnO: Te) thin film, the film shows that a near stoichiometric surface composition as indicated.The prepared film have more than 45% transmission in the corresponding wavelength and determined the thickness of the film is 154nm. The current- potential measurements are also made. Therefore, we propose that Te doped ZnO films may have applications in areas such as the fabrication of microelectronic devices, photovoltaic and sensors due to the doping effects.

Keywords: ZnO:Te thin film, PVD,SEM and EADX and UV studies

1. INTRODUCTION:

Many Nano-structured materials are now being investigated for their potential applications in photovoltaics. Nano-structured layers of thin film solar cells offer three important advantages. First, due to multiple reflections, the effective optical path of absorption is much larger than the actual film thickness. The properties of Nano thin films are susceptible to their structures, crystalline nature of defects and imperfections as well as concentration, compositional variations, etc. and some extent also on thickness, surface topography and asperities. Most of these factors are, however, associated with the growth process of thin films and can be controlled and their effects minimized by taking appropriate precautions. Tellurium doped Zinc oxide (ZnO: Te) is an important semiconductor material for the development of various solid state optoelectronics devices (Laser diodes, solar cells, microwave devices, etc.) due to its specific optical and electrical properties (relatively wide optical band gap, high transparency in visible and infrared regions, low electrical resistivity, etc.[1-5]. This compound does not contain expensive rare metals such as In and Ga, leading to the fabrication of LED with low cost. Some methods have been developed for the preparation of ZnO: Te thin film such as pulsed laser deposition(PLD) [6],Magnetron sputtering[7],Thermal evaporation[8-10], Molecular beam epitaxy(MBE)[11], electronbeam[12], closedspacesublimation(CSS)[13], electrodeposition[14],etc., The choice of deposition method may be based the quality of the films required for specific applications. Among these methods, thermal evaporation is more suitable because of its ability to deposit

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multiple films, friendly environment, non-pollutant, thermal temperature, easy to control the growth factors like film thickness and deposition rate.

2. EXPERIMENTAL:

Thin films of ZnO:Te were grown onto FTO substrate under different conditions. The substrate was cleaned ultrasonically with acetone followed by distilled water. The cleaned substrate was placed in the vacuum chamber. The zinc oxide powder was loaded in the boat made of molybdenum and placed in the vacuum chamber. The pressure of 10-5 was achieved in the vacuum chamber and maintained during the coating. The power supply was used to evaporate the materials. The evaporated material was then condensed onto the FTO substrate.

3. RESULT AND DISCUSSION:

3.1Morphology analysis:

Scanning electron microscope is a versatile technique for studying microstructure of thin film. The surface morphology of ZnO: Te Thin film coated on FTO substrate characterized by scanning electron microscope (SEM) with an accelerating voltage 20 kV. ZnO: Te thin film, we employed with an FTO substrate at instance duration 60 min as shown.Figure (3.1) show that ZnO: Te film at x 1,00000 and 50,000 magnifications of the scale bar length of particle size is 200nm and x 30,000 and 5,000 magnifications of the scale bar length of particle size is 1μm and 2μm for FTO substrate.Surface analysis of ZnO: Te thin film exhibit as a smooth plane surface,that the continuous, finely granulated closed formation. Some conglomeration is formed due to the excess of oxygen flow at the time of processing. It appears more uniform spherical grain.The particle size of this film estimated from their SEM image and reported as shown in the Table.3.1.

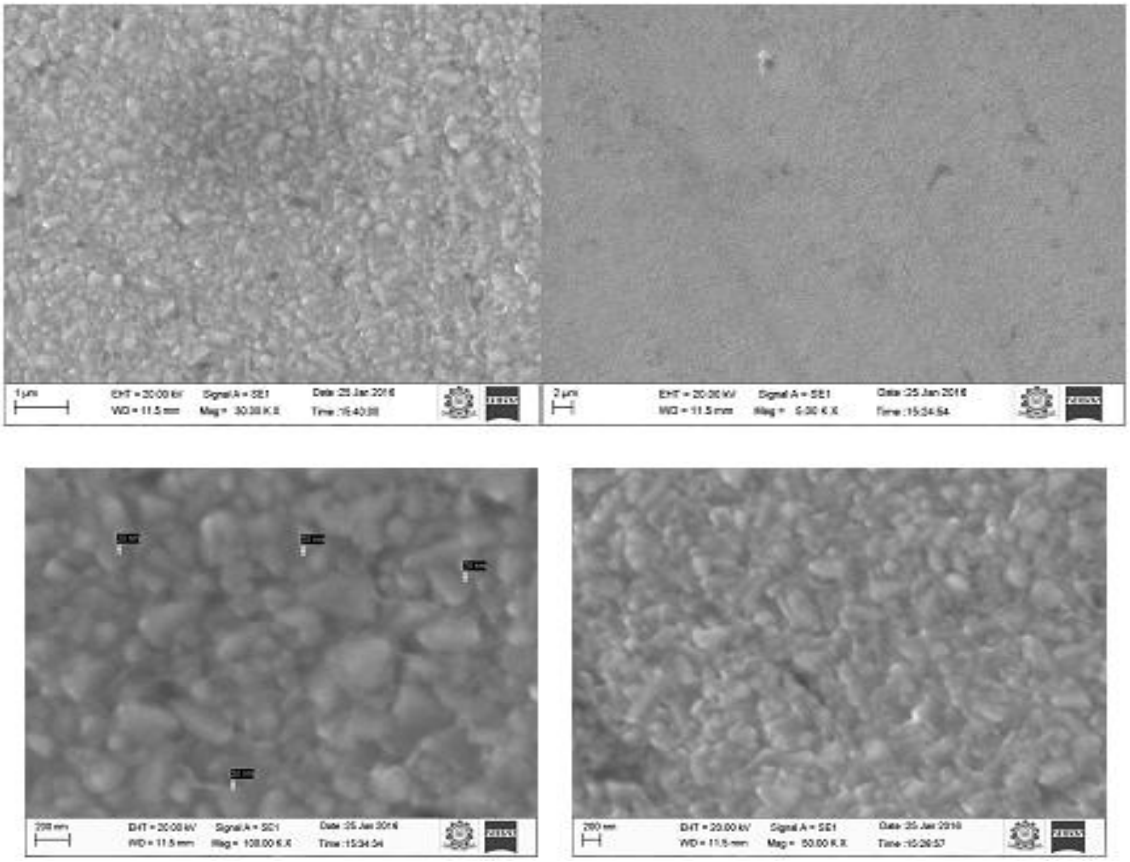

Fig (3.1): SEM images for ZnO: Te on FTO substrate.

Table 3.1: Analysis for SEM pictures

Sample	**Magnification (x)**	**Particle size**
ZnO: Te	1,00000	20nm
	50,000	200nm
	30,000	1µm
	5,000	2µm

3.2 Elemental analysis:

Dispersive x-ray spectroscopy (EDAX) is an analytical technique used for the study of elemental analysis of the sample. It is one of the variants of x-ray fluorescence spectroscopy,which relies on an investigation of samples through interaction between electromagnetic radiation and matter in response hit with charged particles.In order to clarify the element composition of the prepared thin film and evaluation of approximate, atomic ratio, the energy dispersive analysis of x-ray (EDAX) was conducted. It shows the analysis of ZnO: Te thin film.The EDAX analysis revealed the presence of Zn, Te and O elements as shown in the Table 3.2 and also shown in the spectrum.

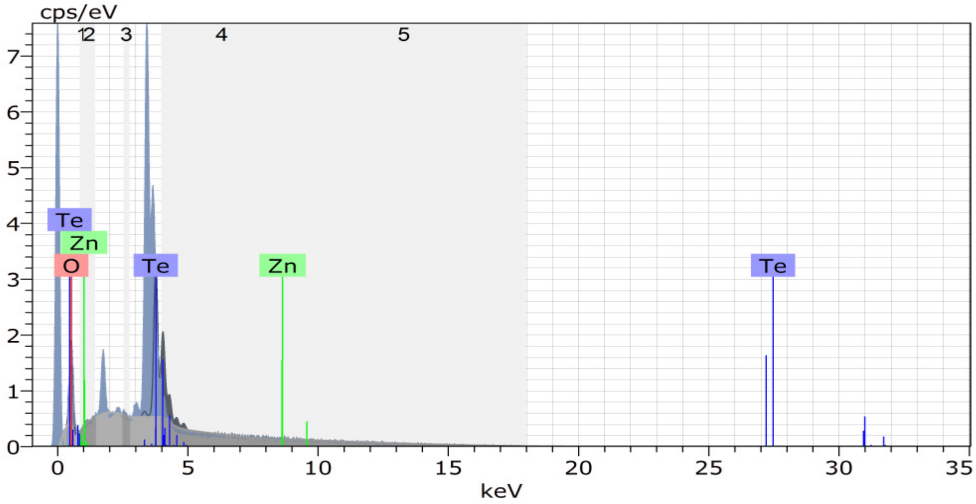

Table 3.2: Elemental analysis of ZnO: Te thin film

Element	**Mass % (g)**	**Atom % (g)**
Oxygen	20.34	66.61
Zinc	1.75	1.40
Tellurium	77.91	31.99
Total	100	100

3.3.DRS-UV analysis:

The optical study of the film concerns not only the physical phenomenon such as reflection, refraction, transmission, absorption, but also the interactions of photon energy with the matter and the consequent changes in the electronic state. The prepared ZnO: Te is coated on FTO substrate is determined from DR- UV –Spectral measurement in the range of 300nm -1100 nm. The absorption maximum values of ZnO: Te were found to be 470 nm. The band gap of semiconductors is related to its range of absorption wavelength and the band gap decreases with increasing of absorption edge. The band gap values of ZnO: Te were found to be 3.1eV. The plot of absorption coefficient squared $(\alpha h\nu)^2$ versus, photo energy (hν) ZnO: Te thin film is shown in Fig.3.3 (a)and Fig 3.3(b).

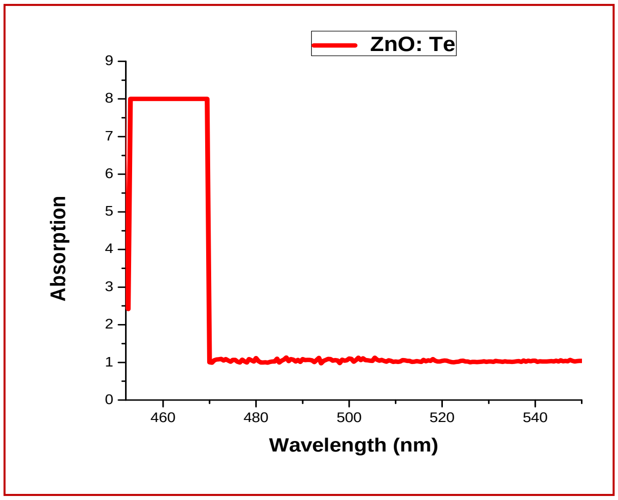

Fig.3.3(a) Absoprtion spectrum

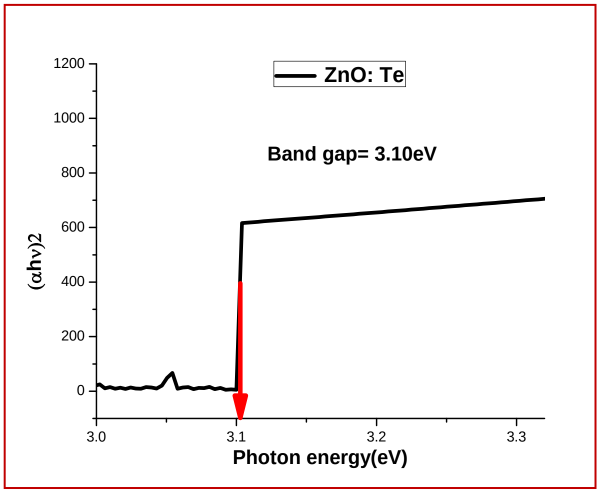

Fig.3.3(b) Energy spectrum

The plot of Reflectance is shown in the Fig.3.4 and plot of transmission is shown in the Fig.3.5 respectively. The ZnO:Te thin film transmission studies were used to determine the thickness is 154nm (t) of the thinfilms and reflectance study was carried out to determine the refractive index is 1.3(n) and extinction coefficient of the thinfilms. These results are tabulated in Table 3.3.

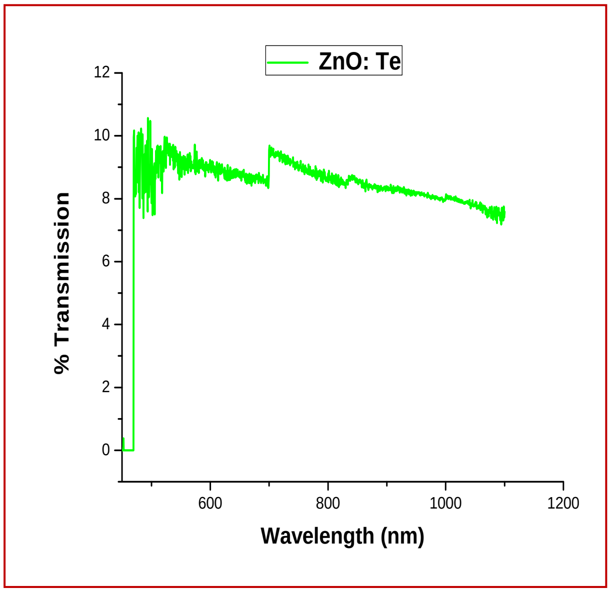

Fig.3.4: Transmission spectrum

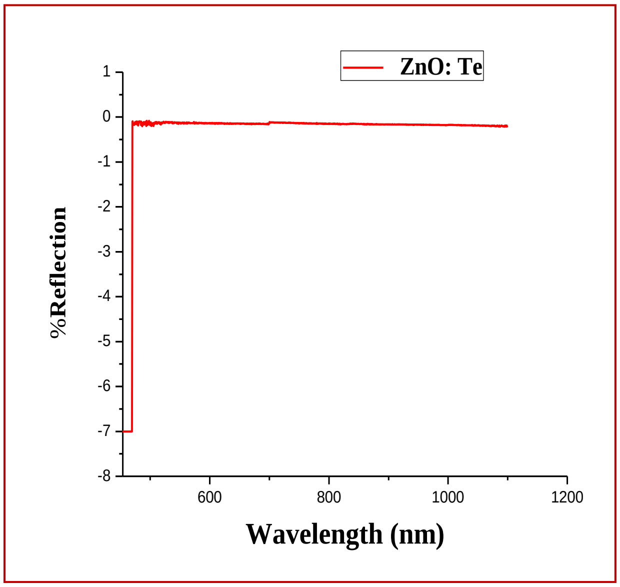

Fig.3.5: Reflection spectrum

Table 3.3:Optical parameters of ZnO: Te thin films:

Sample	**Absorption coefficient (K) (cm $^{-1}$)**	**Thickness of the film (t) nm**	**Refractive index (n)**	**Band gap (E_g) eV**
ZnO: Te	0.7575	154	1.3	3.10

3.4 Electrical properties:

The Tellurium doped zinc oxide (ZnO:Te) thin films and their wring in the structures were prepared onto an FTO substrate by thermal evaporation method and the electrical properties were carried out by conductivity and resistivity of the film and corresponding to the thickness of the film. The material is depended on the temperature and thickness of the film. The resistivity and temperature of these materials ranges are reported and also the potential varies with current as shown in the fig. 3.6 and fig. 3.7. Thin films have been good semi-electrical conducting behaviour in the presence of the external field. The film has been ohmic region extension due the presence of elements, lower dislocation density and also the quantum confinement in the direction of thickness. These values are reported as shown the figures 3.6 and 3.7

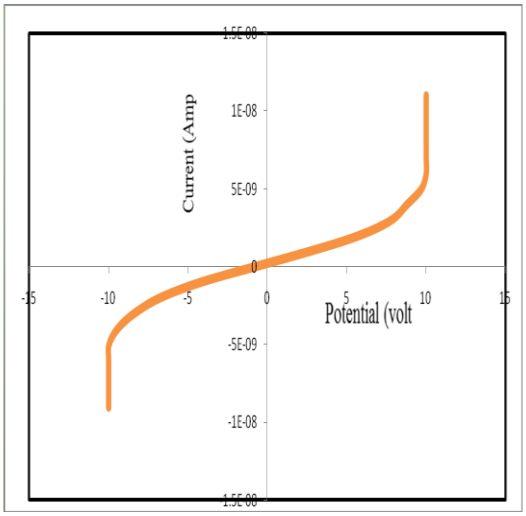

Fig 3.6: V-I curve for Tellurium Doped Zinc Oxide

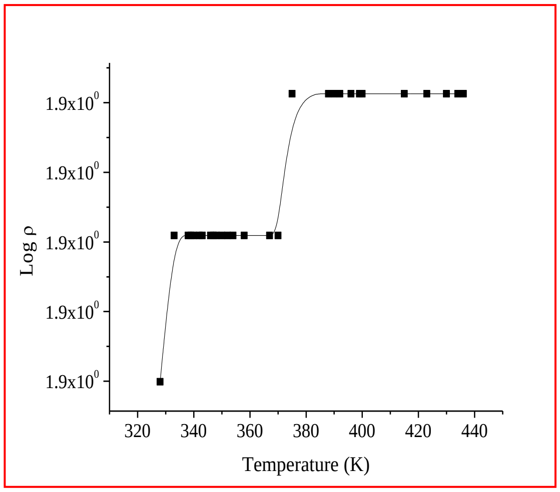

Fig 3.7: K vs ρ curve for Tellurium Doped Zinc Oxide

4.CONCLUSION:

PVD method is used to prepare ZnO: Te thin film.The preparation of ZnO: Te thin film using thermal evaporation method and prepared thin film samples was characterized using advanced, sophisticated instrumentation.The morphological characteristics of ZnO: Te thin film has studied using SEM instrumentation. The SEM image shows that continuous, finely granulated closed formation.From EDAX the elemental analysis give authority to confirm that the prepared films of ZnO: Te.Optical properties of ZnO: Te thin films are studied. J-V performance of solar cells is reported the efficiency of the ZnO: Te thin film. The study will identify the ZnO: Te deposited by PVD method and the physical properties were estimated and explored. Therefore, we propose that Te doped ZnO films may have applications in areas such as the fabrication of microelectronic devices, photovoltaic and sensors due to the doping effects.

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