Preparation of zinc telluride thin films using chemical bath depositon

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Thin film of ZnTe have been synthesized using chemical bath method for different periods (30, 50 and 70 min), the surfaces of these films were imaged using a scanning electron microscope, and the amount of each element of zinc and tellurium was determined in each film depending on the deposition period. The study of optical properties included measuring the transmittance and absorbance with wavelength, we used these measurements to calculate the energy gap and its variation with the deposition time.

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1. Introduction

Zinc telluride (ZnTe) is either grayish-reddish brown powder, or sapphire red crystals when refined by sublimation. It has a direct energy gap (2.26 eV) at room temperature [1] and the energy gap for Telluride zinc varies depending on the source of zinc used. When zinc sulfate is used, the energy gap is between (2.65_ 2.75 eV) and when using zinc chloride, the energy gap is between (2.70-2.87 eV) [2], with a lattice constant (0.61034 nm), possesses little resistance.

Zinc telluride is easy to dope, so it is considered one of the most semiconducting materials used in the field of optical electronics, being more sensitive to green/UV-light (500 nm) [3] and it has a good optical absorption coefficient [4].

Zinc telluride is a semi-conductor of type (p). Most semiconductors possess a crystalline structure of type (zinc blend), but a few of the group's compounds (II-VI) crystallize in a different way known as (wurtzite) [5]. ZnTe is formed by two phases , (cubic) is called (Sphalerite) that resembles diamond (this phase is unstable and formed in particular from electrochemical processes) and hexagonal type and is called (Wurtzite) and has a stable thermodynamic composition and is indirectly formed by the process of annealing the cubic phase or directly by other methods of preparation[5]

In this study, thin films of ZnTe were prepared at different precipitation times, the effect of precipitation time variation on the optical and structural properties have been investigated for all layers.

2. Experimental method

Zinc telluride thin films (ZnTe) were precipitate on glass substrate by Chemical bath deposition technique. The substrates were cleaned in successive steps using methanol and hydrofluoric acid.

Tellurium oxide (TeO_2) with concentration (0.4 gm) was dissolved in 30ml of distilled water to provide Te while Zinc chloride ($ZnCl_2$) with concentration (0.35 gm) was dissolved in 30ml as a source for Zn. Hydrochloric acid was added to Tellurium oxide until the solution become clear, both solution then mixed and stirring for 2 hr, the precipitation solution temperature was fixed at 85 C°.

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Three glass substrates immersed vertically in the later solution for three precipitation times (30, 50 and 70 min) as shown in Fig. 1.

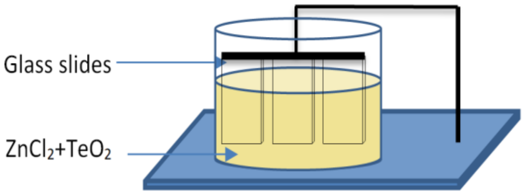


Fig. 1. Chemical bath deposition technique.

The thickness of the layer were measured using weight method using the following equation:

$$T=w_2-w_1/\rho A \quad (1)$$

where w_1 and w_2 film weight before and after precipitation (gm)
ρ density of ZnTe (gm/cm3)
A film area (cm^2)

3. Results and discussion

The transmittance, absorbance were measured for the prepared layers of ZnTe thin films at different precipitation time.

The layers show high transmittance with in the wavelength (500-600 nm) and high absorbance within (350-500nm) as shown in Fig. 2. The energy gap varied with precipitation time (30,50 and 70 min), it was decrease with the precipitation time increase, reaching its value about 3.2eV at the precipitation time 30 min , 2.95eV at 50min and 2.5eV at 70 min [7] [8].

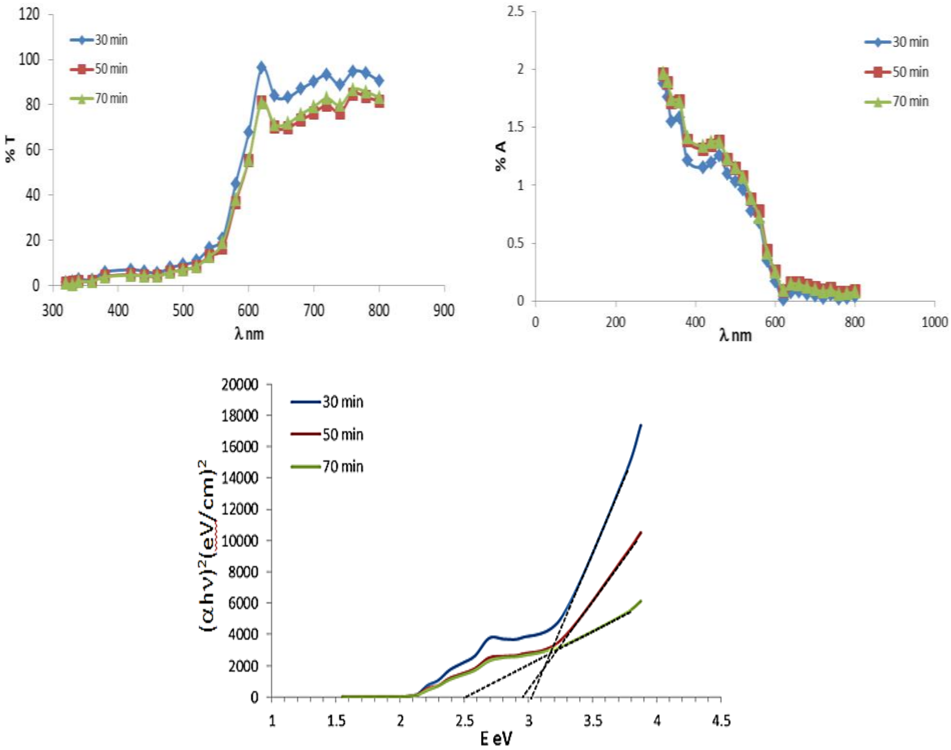
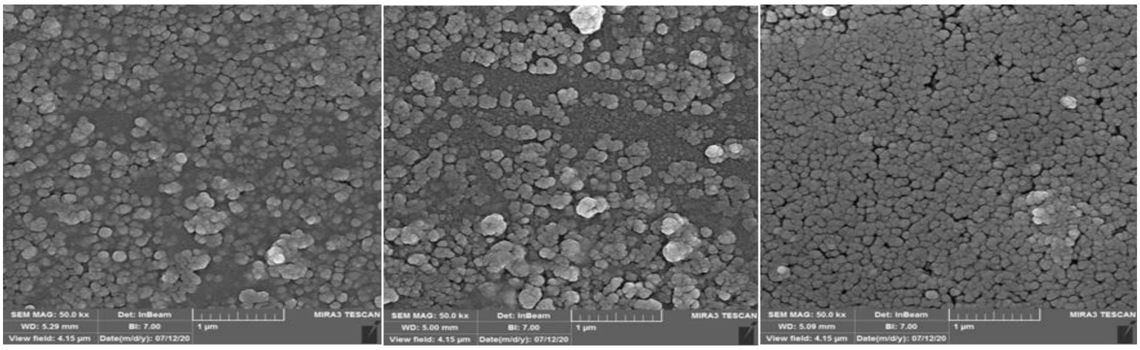


Fig. 2. The optical properties of ZnTe thin flims (a) transmittance (b) absorbance (c) absorption coefficient.

The images of scanning electron microscope clarified the growth and aggregation of grains with precipitation time which result an increase in the grain size as shown in Fig. 3. The increase of precipitation time will increase the homogeneity of the layers [9,10].



a) *b)* *c)*

Fig. 3. SEM images of ZnTe thin films prepared at precipitation time (a) 30min (b) 50min (c) 70min.

The Energy dispersive spectrum show the increase in the ZnTe content of the layers with precipitation time [11,12]. The increase in the membrane content of zinc and tellurium led to an improvement in the homogeneity of the membrane, which was reflected on the optical properties, the most important of which is the value of the energy gap and this agrees with the electron microscope images and the energy gap values in Fig. 3 and Fig. 2, respectively.

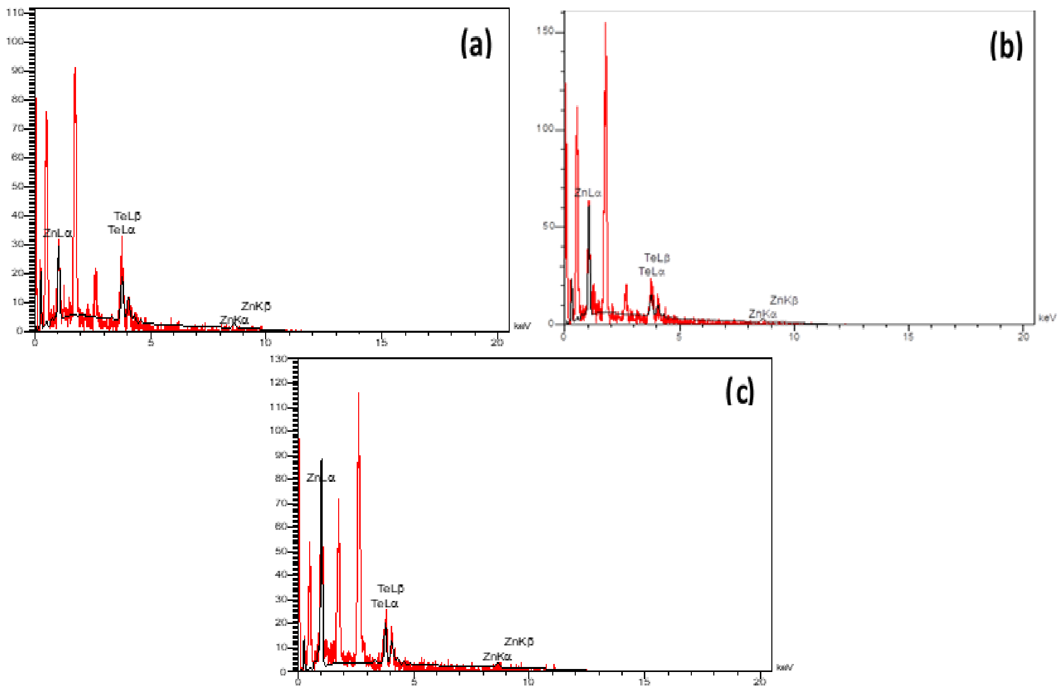


Fig. 4. Shows EDS spectrum for ZnTe thin films with different precipitation times (a) 30min (b) 50min (c) 70min.

4. Conclusion

Thin films of ZnTe deposited using chemical bath deposition CBD, the energy gap decreased from 3.2eV at 30min precipitation time to 2.5eV at 70min. The increases of precipitation time will increase grain size and enhance the homogeneity of the films.

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