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Electrochemical Deposition of CdTe Thin Films at Various Voltages

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Abstract: ***Electrochemical deposition was employed to producing of CdTe thin films. Optical properties were analyzed by using UV-Vis spectrophotometer. The results of Uv-Vis showed that the energy gaps were varied between 0.91 and 1.15 eV. Structural properties were investigated by using XRD pattern. According to the XRD results, CdTe thin films were obtained in some experiments. The surface morphologies of the films were investigated SEM images.***

Keywords: CdTe; cadmium telluride; electrodeposition; thin films

1. Introduction

The electrochemical deposition (or simply electro-deposition) of CdTe for the producing of CdS/CdTe solar cells has received research attention for quite some time now. Te manufacturability and scalability of this simple but powerful process have been undoubtedly demonstrated by British Petroleum (BP Solar) company in the late 1990s by the production of solar panels of ∼1 m2 with over 10% conversion efficiency [1] Various techniques have been reported for preparation of CdTe thin films such as physical vapour deposition (PVD), RF sputtering, spray pyrolysis, close-space sublimation (CSS) and electrodeposition (ED) [2]. Electrodeposition as a semiconductor deposition technique was opted for due to its comparative advantages with respect to deposition process continuity, low-cost, simplicity, scalability and Cd-containing waste reduction amongst other advantages. The two-electrode electrodeposition configuration was utilized due to its industrial applicability, process simplification and also eliminates possible K and Ag ions doping which may emerge from the reference electrode. [3]

2. Experimental Procedure

In this study CdTe thin films were obtained electrodeposition technique. Before the deposition, solution container and ITO coated glass substrates were washed with acetone. After than container and substrates washed by using deionized water. Chronoamperometry method of electrodeposition was used. The experiments were carried out in a conventional three electrode electrochemical cell with a platinum wire, counter electrode, and a saturated calomel reference.

1.5 M $CdCl_2$ was dissolved in 100 mL glass container. Subsequently, 0.02M Na_2TeO3 was dissolved in container. The pH was adjusted 3.3 by using $C_6H_5Na_3O_7$ Sodium citrate dihydrate.

The temperature was kept at 20±2 °C for all during the deposition. Besides, solutions were stirred at 600 rpm. After the depositions, samples were washed deionized water and left to dry in room condition.

The absorbance values of the CdTe films were obtained by using JASCO V–530 double beam spectrophotometer device. The wavelengths of devices were chosen between 550 and 950 nm. The structures of the films were received by a PANalytical empyrean X-ray diffractometer. The morphologic characterizations of the films were investigated with a Zeiss supra 40VP SEM.

3. Result and Discussion

3.1 Structural studies of CdTe thin films

The thicknesses were calculated by well-known gravimetric method. For all samples, thicknesses were calculated average 650 nm.

The XRD patterns were given in Fig. 1. According to the Fig 1, when CdTe was obtained at -0.40 V potential, it was seen that there are tellurium peak. All the Te peaks is matched (98-004-0041) and (98-005-2051) ASTM card. Besides, intensities of the Te peaks of the films were relatively high. When the film obtained at -0.80 V formed in that there are only CdTe peaks. These peaks are well matched to ASTM cards of (98-016-1692) and (98006-7862).

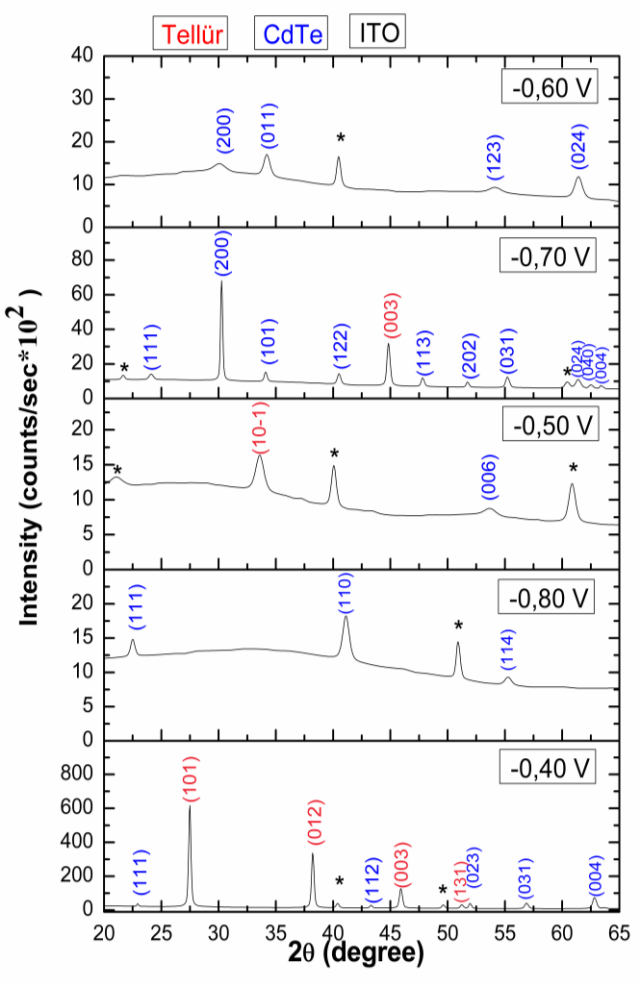


Figure 1: XRD patterns according to voltage

3.2 Optical properties of the films

The absorbance measurements of the films were given in Fig. 2. It is seen from the Fig 2 that when voltage was chosen -0.40V, the absorbance was low. It may be said that differences of the film surface was caused this result.

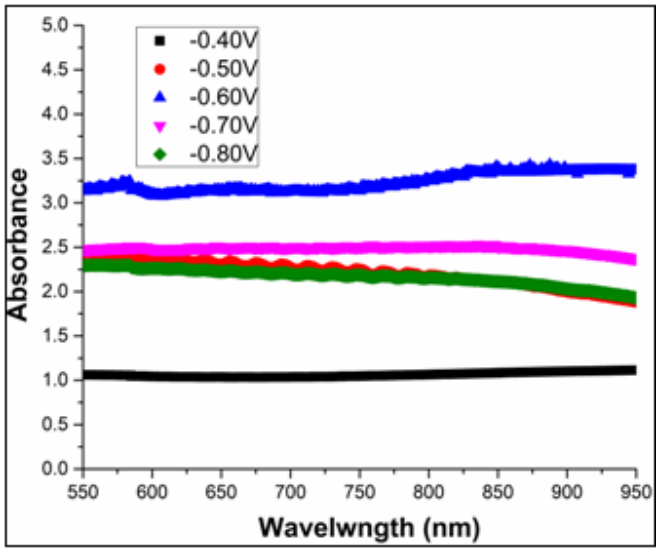


Figure 2: Absorbance measurements of the films

The energy band gap was estimated by using Tauc plots. The Tauch plots were given in Fig. 3.

According to the plots, energy band gap of the films were varied between 0.91 eV and 1.15 eV. On the other hand band gap of the CdTe is 1.4 eV [4].

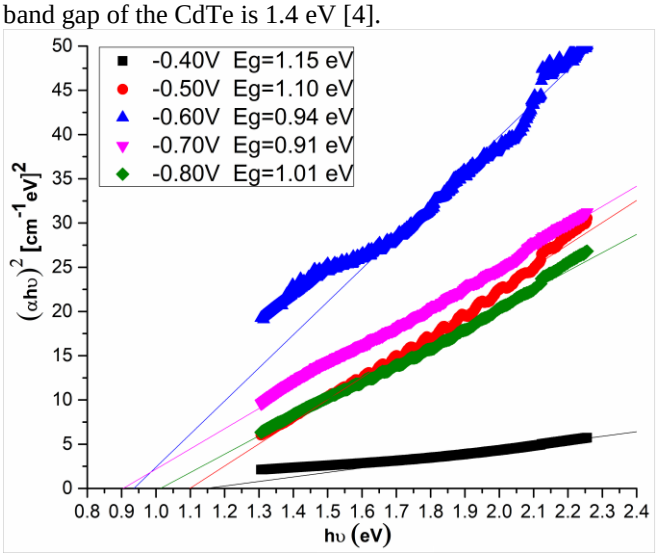
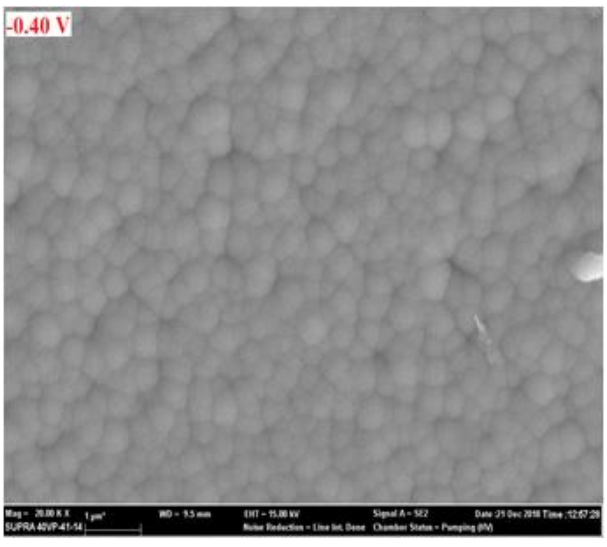


Figure 3: Tauc plots of the films.

3.3 Surfaces of CdTe thin films

The surfaces were analyzed by using SEM images. The surfaces images were magnified 20000 times. The SEM images were given in Fig 4 and Fig 5. It is seen from the Fig. 4 surfaces are different from each other. In the figure it is shown that when CdTe were produced at -0.40 and -0.50 V, the surface covered by like as spherical form. The grain sizes were varied between 611 and 440 nm the other was between 1833 and 666 nm, respectively. The SEM images of the films obtained at -0.60 and -0.70 V were compact and pinhole free. For these two films grain sizes was varied between 1667 and 1111 nm, and the other was varied 1660 and 1000 nm. When the SEM images of the film obtained at -0.80 V was investigated, the crystals were covered surface like as stars form.



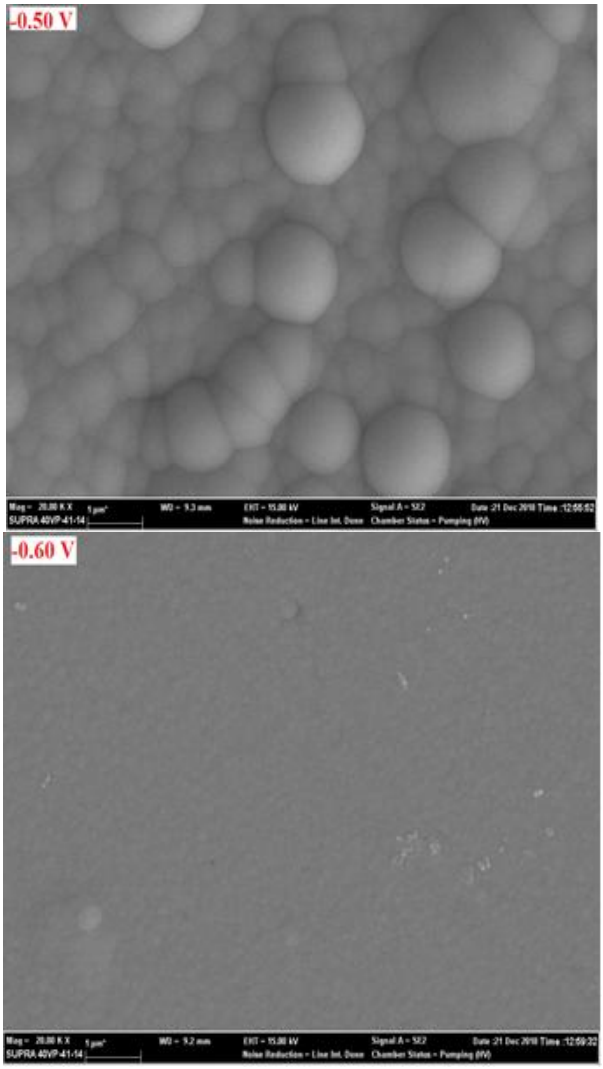
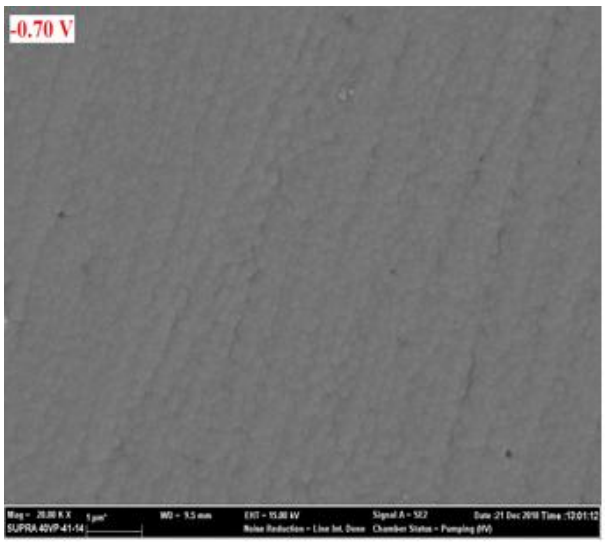


Figure 4. SEM images of the films obtained with -0.40, -0.50 and -0.60 V



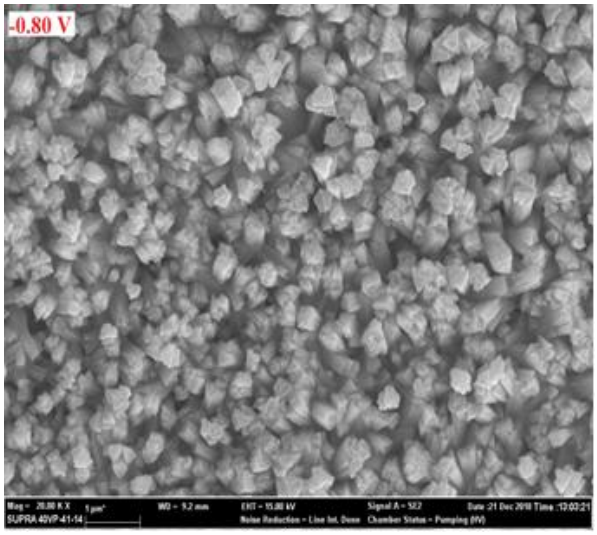


Figure 4: SEM images of the films obtained with -0.70 and -0.80 V

4. Conclusions

In this work, thin films of CdTe were obtained by electrodeposition method. According to the XRD analysis, the Te free thin films can be obtained. The energy band gaps of the films varied between 0.91 eV and 1.15 eV. These values are relatively low. The surface investigated by using SEM images. According the SEM images various images were obtained by varied voltage.

5. Acknowledgement

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