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Studies on electrodeposited $CdSe_xTe_{1-x}$ films

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Thin films of $CdSe_xTe_{1-x}$ were prepared on SnO_2 and Ti substrates by the electrodeposition technique. The films were heat treated in air at temperatures in the range 573-773K. Structural and optical absorption studies were made on these films. Preliminary investigations on the photoelectrochemical (PEC) characterization of the films indicated good photoactivity in the polysulphide electrolyte.

Key words: Electrodeposition, $CdSe_xTe_{1-x}$ film, semiconductors

INTRODUCTION

The demonstration of an 8% efficient liquid junction solar cell based on polycrystalline thin film $CdSe_{0.65}Te_{0.35}$ has created a great deal of interest in this system [1]. CdSe and CdTe form solid solutions over the entire composition range and at the above composition, have exhibited Eg~1.35-1.45 eV lower than CdSe (1.75 eV). A 60% increase in photo-current density has been observed, over CdSe material. Further PEC cells based on $CdSe_xTe_{1-x}$ films have been observed to be stable for more than an year [2]. In view of the appropriate bandgap for energy conversion, good stability and efficiency, work on the growth of good quality $CdSe_xTe_{1-x}$ films for fabrication of PEC cells for energy conversion and storage was undertaken here. In this paper, results on the preparation and PEC characteristics of $CdSe_xTe_{1-x}$ films are reported.

EXPERIMENTAL

$CdSe_xTe_{1-x}$ thin films were prepared electrochemically from a plating solution containing $CdSO_4$, SeO_2 and TeO_2 on titanium substrates. Deposition was carried out at room temperature under stirred conditions. A Pt counter electrode and a SCE as reference were used. The as - grown films were heat treated in air at different temperatures in the range 573-773K. The thickness of the heat treated films were in the range of 1.9-2.2 μm. The films were characterized by X-ray diffraction studies. The optical absorption measurements were carried out on the films deposited on conducting glass using a Hitachi U 3400 spectrophotometer. The PEC cells were constructed using $CdSe_xTe_{1-x}$ films as photoanodes and Pt as counter electrode. The electrolyte was an alkaline polysulphide redox of composition 1M NaOH-1MNa_2S-1M S. The I-V characteristics of the cell were recorded at different intensities with a 250 W tungsten halogen lamp as the light source.

RESULTS AND DISCUSSION

The X-ray diffraction (XRD) patterns of the heat treated as well non-heat treated films are identical. Sharp diffraction peaks indicate the polycrystalline nature of the deposit. The X-ray diffractogram of a film heat treated at 773K is shown in Fig. 1. These results are similar to those observed by earlier workers [3]. The film composition was calculated from Vegard's rule [4], expressed as follows:

$$^{a}CdTe^{x} + ^{(1-x)a}CdSe = ^{a}\text{obtained} \quad (1)$$

$$^{c}CdTe^{x} + ^{(1-x)c}CdTe = ^{c}\text{obtained} \quad (2)$$

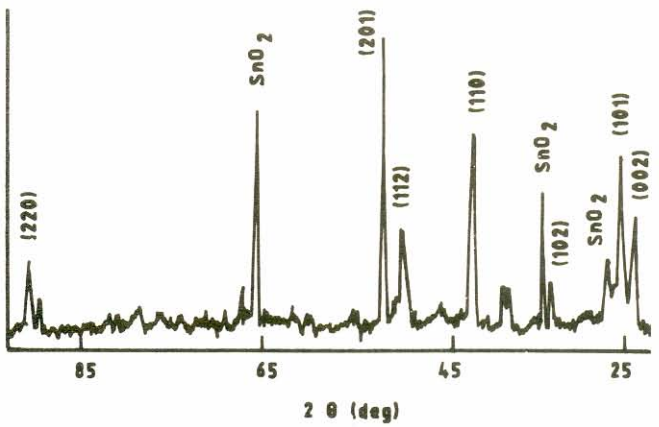

Fig. 1: XRD of $CdSe_xTe_{1-x}$ film

The composition obtained from eqn. (1) is $CdSe_{0.23}Te_{0.77}$ while that from eqn. (2) is $CdSe_{0.28}Te_{0.72}$.

The optical absorption data of the samples heat treated at different temperatures have been analysed and all the samples have been observed to follow the direct transition relationship,

$$\alpha = \frac{A}{h\nu}(h\nu - E_g)^{1/2} \quad (3)$$

The bandgap values increase from 1.5 to 1.65eV as heat

treatment temperature increases.

The I-V characteristics of $Ti/CdSe_xTe_{1-x}$ electrodes were studied under various illumination intensities in the range 500-100 $mWcm^{-2}$. Figure 2 depicts the I-V characteristic of the $CdSe_xTe_{1-x}$ electrode. V_{oc} = 358mV and J_{sc} = 0.65 mA were obtained. The series resistance (R_s) has been calculated to be 101 ohms. The shunt resistance (R_{sh}) was found to be 330 ohms.

Thus the results of the present study clearly indicate that good quality $CdSe_xTe_{1-x}$ films could be obtained by electrodeposition. From the analysis of the optical absorption spectrum, a bandgap value of 1.64 eV is obtained (closer to that of CdSe(1.70eV).

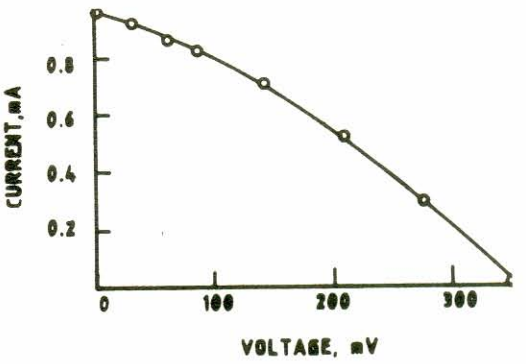

Fig. 2: I-V Curve

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