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Mn Doped CdSe thin Film preparation and characterization

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ABSTRACT

Manganese doped CdSe thin film ware obtained by the potentiostatic technique in a three electrode setup. Electrosynthesis of Mn Containing CdSe films have been electrosynthesis at -0.600V vs SCE on titanium substrate from the aqueous solution. Electrochemical proportion of films were investigated in I_2/ I^- redox Solution.

The composition of electro synthesized films were determined by energy depressive X-ray analysis, SEM and capacitance measurements. The corrosion characteristics of the film have been studied by polarization technique. This is the study to investigate the effect of manganese concentration on the composition, capacitance, morphology and corrosion parameters of the CdSe Mn Films electrosynthesis by electrodeposition.

Key words: Electrosynthesis, potentiostatic, electrodeposition, electrochemical.

INTRODUCTION

CdSe is one of he most promising materials solar energy conversion because it has low energy gap and direct optical transition takes place. Several methods have been used to prepare thin films. The thin film electrochemical synthesis method is a simple and versatile method for preparing semiconductor materials. The material can be obtained under very mild condition, under atmospheric pressure and at a room temperature. The cathodic deposition route involving the co-reduction of chalcogenide has been extensively studied.

In this paper we will report our work on electrochemical preparation and characterization of Mn doped CdSe thin film on the basis of electrochemical, corrosion, compositional and morphological analysis.

EXPERIMENTAL

Mn doped CdSe thin film were synthesized by electrochemical codeposition method potentiostatically from aqueous solution on the titanium sheet. The deposition potential was maintained to -0.600 V v/s saturated calomel electrode (SCE).

The electrode were clamped in an electrochemical cell for equilibrium. A platinum counter electrode and SCE (Reference electrode) were used for the deposition. The deposition process take place in this arrangement that time being employed a platinum counter electrode. The power supply (Systronics) was used for application of the potential for deposition.

Electrochemical studies on a Titanium electrode were carried out in order to find the deposition condition for Mn doped cadmium selenide compounds. The deposition solution of thin film of Mn, Cd, Se are presented in table 1.

Electrochemical deposition was carried out at room temperature and electrodes were kept

Table - 1: Deposition solution for Cd, Se and Mn.

Cd	-	0.1 M.
$CdSo_4$		
Se	-	0.01 M.
Seo_2		
Mn	-	0.00025 M
$Mnso_4$	-	0.0005 M
		0.00075 M
		0.0010 M

in electroplating solution for one hour for equilibration. The morphology and composition of the film were investigated by SEM and EDAX. The capacitance measurement was done with help of a digital LCR (Systronics), For corrosion behavior the electrodeposits were used as a working, titanium as a counter and SCE as a reference electrode. Anodic and catholic polarization was carried out for the purpose of constriction of Tafel plots and corrosion parameters.

RESULT AND DISCUSSION

Reduction of Mn ions starts at about –0.6 V v/s SCE, the composition of the synthesis both for the CdSe and Mn was approximated in order to obtain cadmium as the base components and the other two metals representing less.

The current as a function of time for the deposition of thin film on a titanium electrode at the –0.600 v/s SCE potential. It can be noticed initially a decreases of the very fast and is current correlated with the formation of the growth. Variation of current with time for CdSe & Mn containing CdSe films are given in Fig. - 1.

When we change the composition by varying the Mn concentration in electrolyte containing CdSe, initial and steady state current increase which is summarized in Table (2) / Fig. - 2 shows the concentration of Mn inclusion in the films as a function of initially and steady state current density.

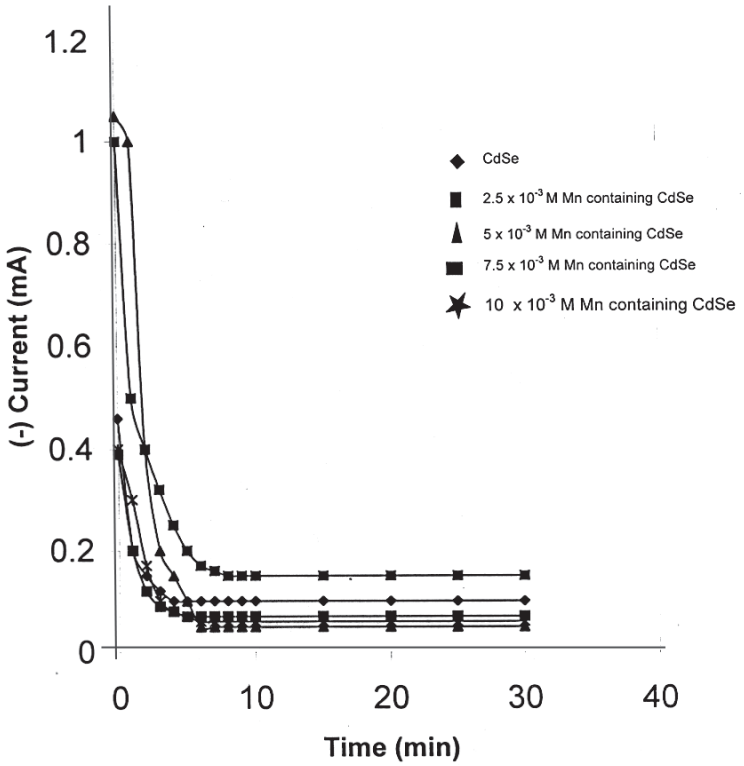


Fig. - 1: Variation of current with time

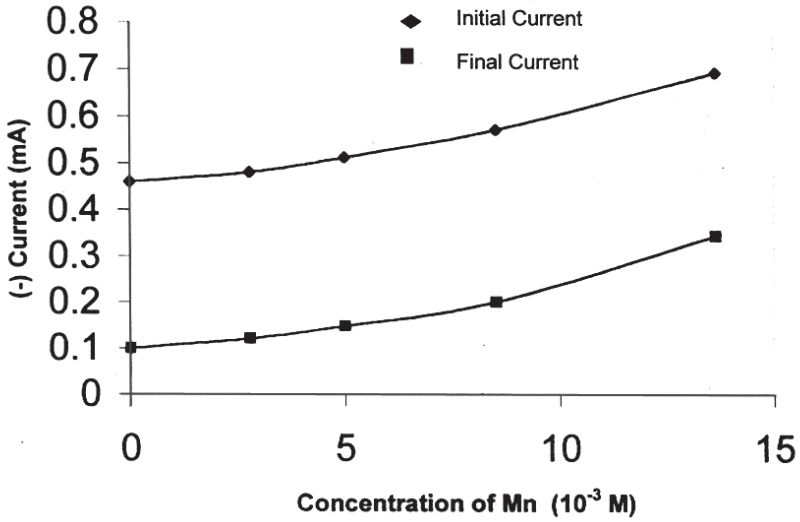


Fig. - 2: Variation of current with Mn concentration

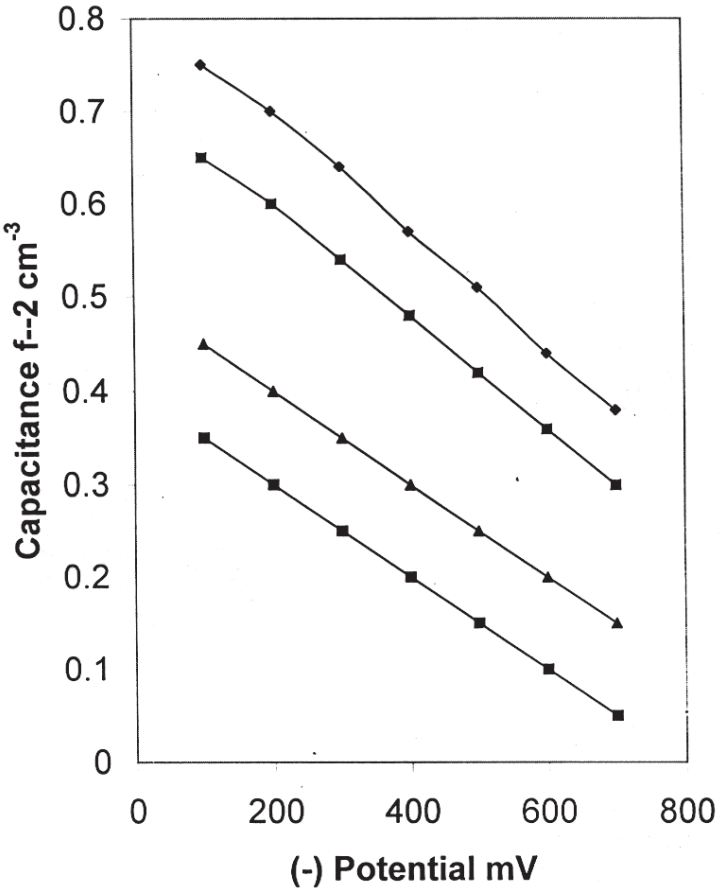


Fig. - 3: The Mott-Schottky plots of CdSe Mn

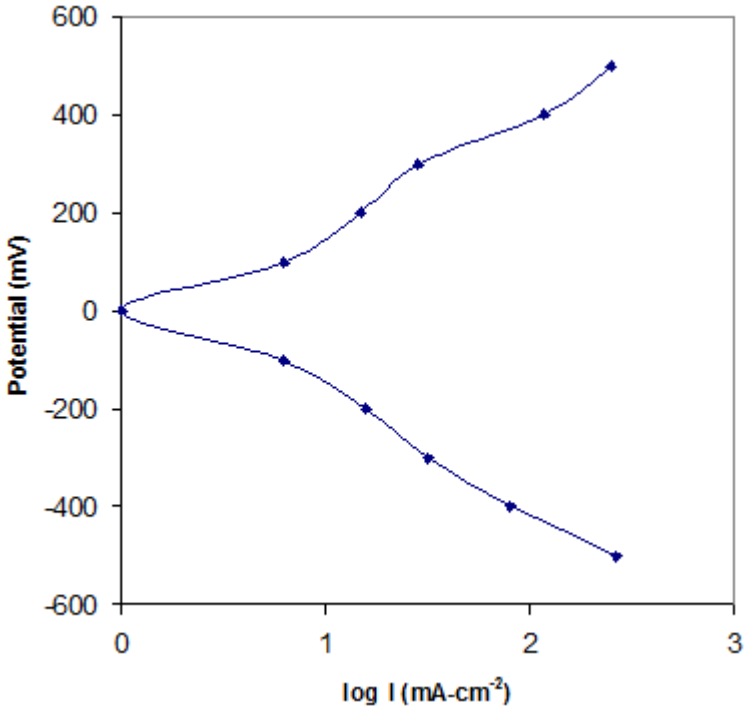
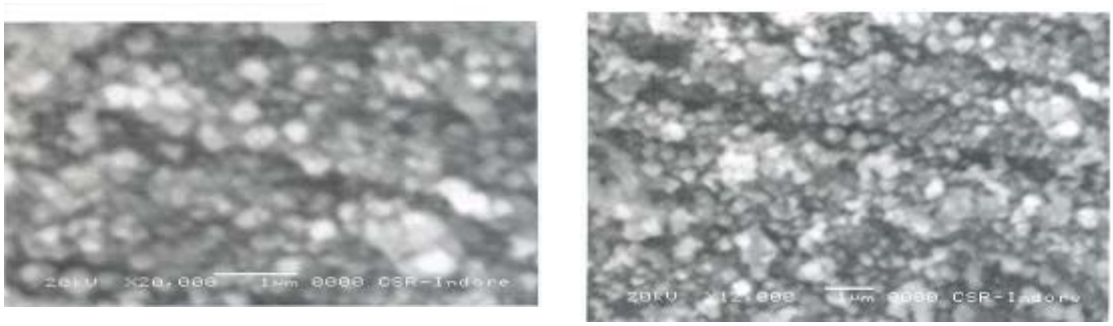


Fig. - 4: Typical Tafel plot for 0.0004 M Mn contaning CdSe



5(A) **5(B)**

Fig. - 5: Sem of (A) 0.0004 M Mn containing CdSe & (B) 0.0010 M Mn containing CdSe

When the Mn content increases in the electroplating solution from 0.0002 M to 0.0010 M with an increase in current density from -0.461mA to -1.240 mA.

The thickness values of the films are estimated from the quantity of charge passed thorough the electrolyte and is given in table 2. Capacitance measurements have been studied for the characterization of deposited films.

The slopes are used to evaluate charge carrier density, flat band potentials are also comes from the intersection of curve at potential axis. Figure 3 shows the variation of capacitance with applied potential for different concentration of Mn containing CdSe electrodes.

The tafel plot carried out at room temperature in I_2/I^- redox solution both anodic and cathodic tafel plots in each case shifted towards

Table - 2: Electrohemical parameters for Mn containing CdSe

Composition of Electro Plating Solution			(-) Current density (MA – cm^{-2})		FilmThickness (10^{-6}) M	Charges carrier Density	Corrosion rate(MPY)
Cd	Se	Mn	Initial	Final			
0.1	0.01	0	0.461	0.090	2.5	3.63	1.42
0.1	0.01	0.00025	0.6 86	0.155	3.2	4.02	0.82
0.1	0.01	0.0005	1.05	0.200	4.6	3.22	0.76
0.1	0.01	0.00075	1.150	0.239	5.8	54.25	0.80
0.1	0.01	0.0010	1.240	0.246	8.9	18.29	0.52

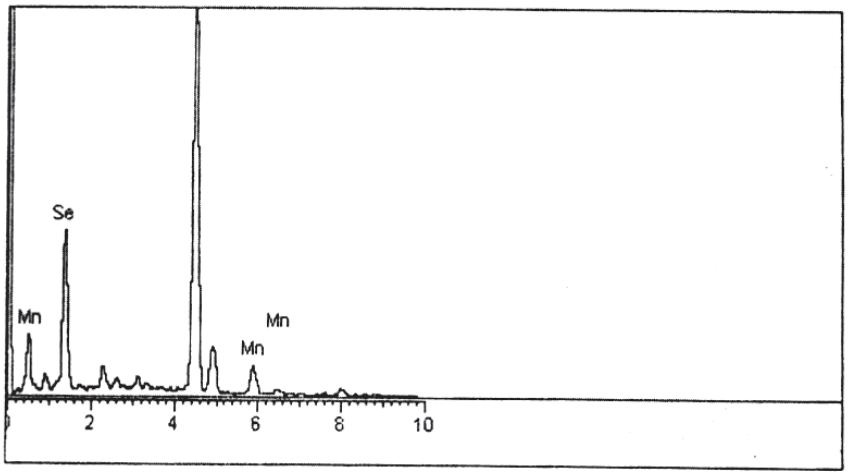


Fig. - 6: EDAX of MnSe

higher polarization level. The corrosion rates of the electrosynthesis film were calculated with the help of equation.

$$CR = \frac{0.13\ I\ carr.\ (Ew)}{d}$$

Where, Ew = equivalent weight;
d-density of deposited materials

The corrosion rate values are given in table 2. The corrosion current decreases with addition of Mn concentration and also corrosion rate decreases. The tafel plats for 0.0004 M Mn containing CdSe is given in figure 4.

Fig 5 shows the scanning electron micrograph of Mn doped CdSe thin films. These micrographs shows that the deposition is homogenous and continues. The morphology of the films affected with addition of Mn concentration. Figures 6 shows a typical plot of EDAX of the MnSe film. The a EDAX studies reveals that the inclusion of Mn in electroplating solution, increases of Mn content in deposited films also.

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