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# Optical Properties of $Cds_xte_{1-X}$ Nanocrystalline Thin Films

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**----------Abstract----------**

*$CdS_xTe_{1-x}$ films were deposited on titanium and conducting glass substrates at different temperatures in the range of 30 to 90°Cusing Brush Plating technique. The as deposited films exhibited hexagonal structure irrespective of the composition. The FWHM maximum of the peaks were found to decrease with increase of duty cycle. Optical absorption studies were made on the films of different composition deposited at 80°C on conducting glass substrates. The band gap was found to vary from 1.44 eV to 2.41 eV as the percentage of CdTe decreased. EDAX measurements were made on the films of different composition heat treated at 550°C. The magnitude of the resistivity varies from 14.9 ohm cm to 10.4 ohm cm as the CdS concentration decreases from 1 to 0. The decrease in resistivity is due to decrease of tellurium vacancies or increase of depth of donor level associated with the tellurium vacancy, similar to the case of CdSTe films.*

***Keywords:*** *CdSTe,Thinfilms,XRD,EDAX.*

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## I. Introduction

Thin film photovoltaic solar cells based on n-type CdS window layers and p-type CdTe absorber layers have been used for the formation of an intermediate layer of $CdS_xTe_{1-x}$ during cell fabrication. This layer results from inter-diffusion and is believed to affect device efficiency through the resulting change in the optical band gap. Thin films of $CdS_xTe_{1-x}$ have been deposited by brush electro deposition method.

## II. Experimental

$CdS_xTe_{1-x}$ films were deposited on titanium and conducting glass substrates at different temperatures in the range of 30 to 90°C.The electrolyte used for the deposition was 0.25 M cadmium sulphate, the concentration of $SeO_2$ and TeO2 dissolved in sodium hydroxide was varied in the range of 0.01 – 0.05 M. As an example, for the deposition of $CdS_{0.5}Te_{0.5}$ film, the precursors were taken with the following concentration, 20 ml of 0.25 M $CdSO_4$, 1 ml of 0.025M $TeO_2$ and 1 ml of 0.025 M $SeO_2$. The pH of the bath was adjusted to 2.0 by adding sulphuric acid. The deposition time was 20 min in all the cases. Thickness of the films estimated by Mitutoyo surface profilometer was 2.0 micrometres. The films were characterized by x-ray diffraction using a PANalytical X-ray diffractometer. Optical absorption measurements were made on the films deposited on conducting glass substrates using Hitachi U3400 UV-VIS-NIR spectrophotometer. EDAX measurements were made on the films using a JEOL SEM fitted with EDAX attachment. XPS studies were made using MK III VG ESCA system.

## III. Results And Discussion

The as deposited films exhibited hexagonal structure irrespective of the composition. The FWHM maximum of the peaks were found to decrease with increase of duty cycle. Fig.(1) shows the XRD pattern of the $CdS_xTe_{1-x}$ films deposited at different temperatures. The intensity of the peaks increased with increase of duty cycle. The peaks corresponding to the (100), (002), (101), (102), (110and (112) reflection were observed in all the cases. The peaks were found to shift from CdTe to CdS side as the concentration of CdS increased in the films.

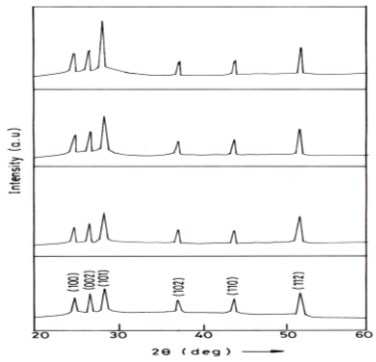



Fig.1– X-ray diffraction pattern of $CdS_xTe_{1-x}$ (x = 0.1) films deposited at different temperatures (a) 30°C (b) 50°C (c) 70°C (d) 90°C

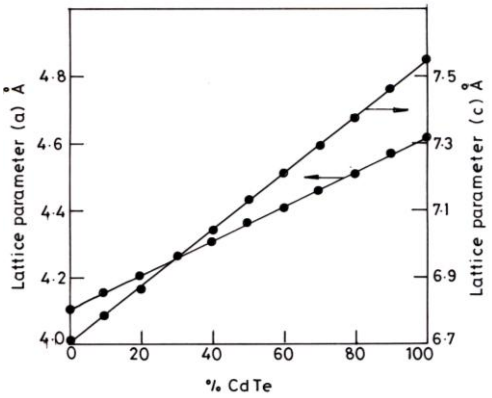



Fig.3 – Variation of lattice parameter with increase of CdTe

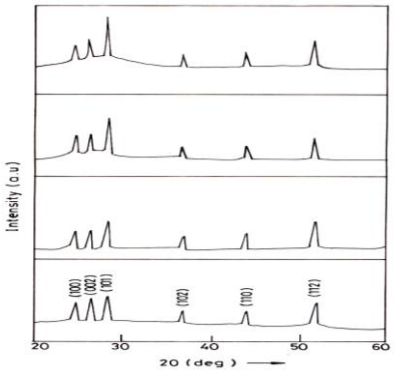



Fig.2- X-ray diffraction pattern of $CdS_xTe_{1-x}$ (x = 0.2) films deposited at different temperatures (a) 30°C (b) 50°C (c) 70°C (d) 90°C

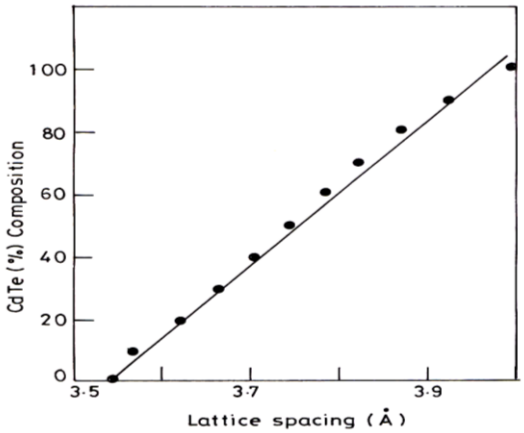



Fig.4– Variation of lattice spacing with increase of CdTe

## IV. Optical Studies

Optical absorption studies were made on the films of different composition deposited at 80°C on conducting glass substrates .Fig.5 and Fig.6 shows the plot of $(\alpha h\nu)^2$ vs hν. The extrapolated values of the optical energy gap, $E_g$, are in the range of 1.54 – 2.32 eV for films of different composition, it is observed that the band gap shifts towards CdS side as the concentration of CdS in the films increase. Fig.6.14 shows the variation of bandgap with CdTe percentage. The band gap was found to vary from 1.44 eV to 2.41 eV as the percentage of CdTe decreased.The optical constants, refractive index(n) and extinction coefficient(k) were evaluated from the transmission spectra of the films of different composition.

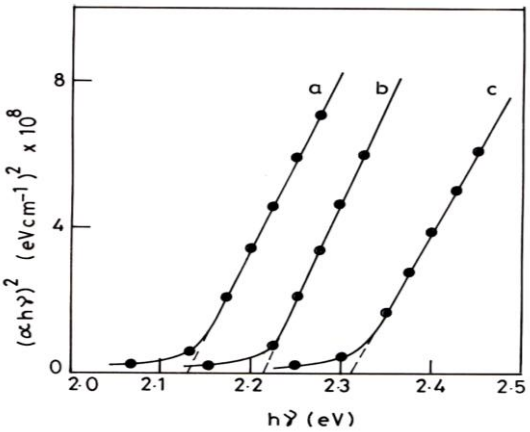
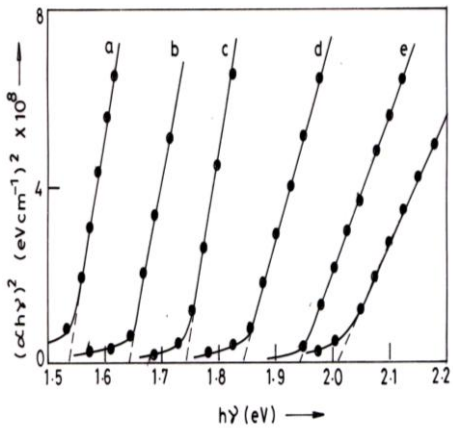



Fig.6 – $(\alpha h\nu)^2$ vs hν plot of $CdS_xTe_{1-x}$ films of different composition deposited at 90°C (a) x = 0.7 (b) x = 0.8 (c) x = 0.9



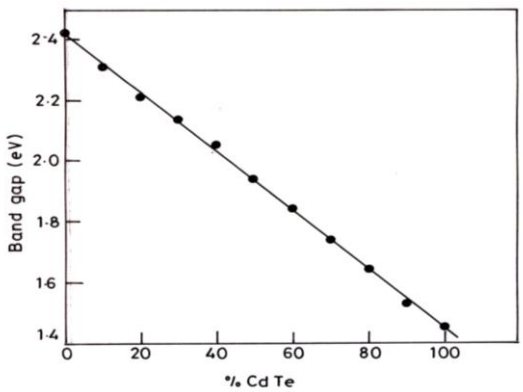




Fig.5 – $(\alpha h\nu)^2$ vs hν plot of $CdS_xTe_{1-x}$ films of different composition deposited at 90°C (a) x = 0.1(b)x = 0.2 (c) x = 0.3 (d) x = 0.4 (e) x = 0.5 (f) x = 0.6

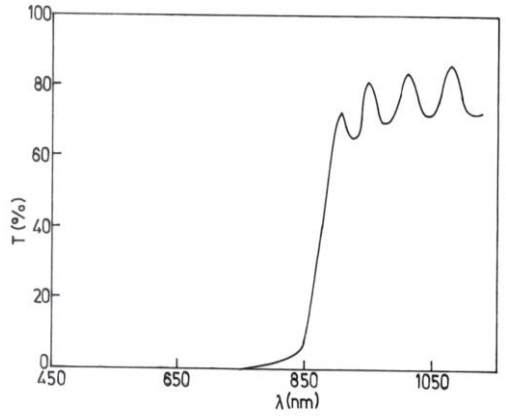



Fig.8 – Transmission spectrum of $CdS_xTe_{1-x}$ ((x = 0) films deposited at 90°C

## V. EDAX Studies

EDAX measurements were made on the films of different composition heat treated at 550°C and the EDAX spectrum is shown in Fig.9 & Fig.10 Peaks corresponding to $CdL\alpha_1$, $TeL\alpha$, S $K\alpha$ were observed in the EDAX spectrum**.**

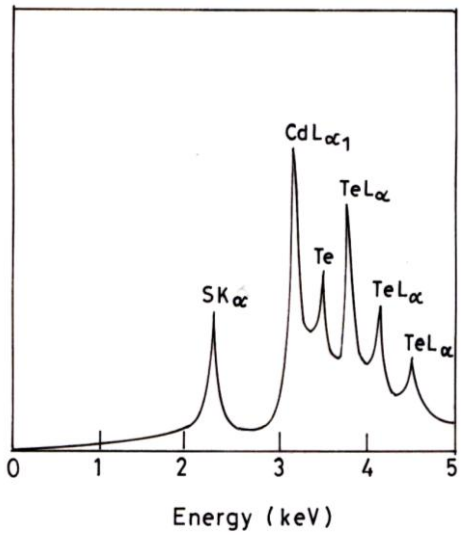



Fig.9 – EDAX spectrum of $CdS_xTe_{1-x}$ (x = 0.1)films deposited at 90°C

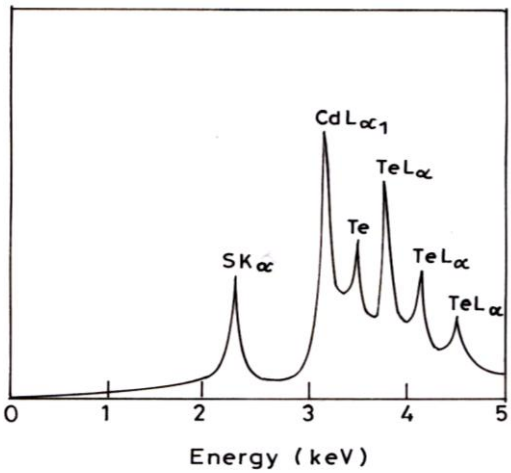



Fig.10 – EDAX spectrum of $CdS_xTe_{1-x}$ x = 0.2)films deposited at 90°C

**Table.1 indicates the composition of the films of different composition after post annealing at 550 °C.**

**Table.1Composition of the $CdS_xTe_{1-x}$ films**

| Starting Composition | EDAX Analysis |
|---|---|
| $CdS_{0.9}Te_{0.1}$ | $CdS_{0.87}Te_{0.13}$ |
| $CdS_{0.8}Te_{0.2}$ | $CdS_{0.79}Te_{0.21}$ |
| $CdS_{0.7}Te_{0.3}$ | $CdS_{0.71}Te_{0.29}$ |
| $CdS_{0.6}Te_{0.4}$ | $CdS_{0.57}Te_{0.43}$ |
| $CdS_{0.5}Te_{0.5}$ | $CdS_{0.50}Te_{0.50}$ |
| $CdS_{0.4}Te_{0.6}$ | $CdS_{0.37}Te_{0.63}$ |
| $CdS_{0.3}Te_{0.7}$ | $CdS_{0.27}Te_{0.73}$ |
| $CdS_{0.2}Te_{0.8}$ | $CdS_{0.18}Te_{0.82}$ |
| $CdS_{0.1}Te_{0.9}$ | $CdS_{0.09}Te_{0.91}$ |

## VI. Electrical Properties

The magnitude of the resistivity varies from 14.9 ohm cm to 10.4 ohm cm as the CdS concentration decreases from 1 to 0. The decrease in resistivity is due to decrease of tellurium vacancies or increase of depth of donor level associated with the tellurium vacancy, similar to the case of CdSTe films.

## VII. Conclusion

This study clearly indicates that CdSTe films with low resistivity can be easily prepared by the Brush plating technique. The value of Carrier concentration decreases as the annealing temperature increases. Optical absorption studies indicates the band gap vary from 1.44 eV to 2.41eV. the results obtained in the investigation indicates that the film source reasonable photoconductive responses and Photo response.

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