



Study of Structural Properties of Annealed CdO and ZnO Thin Films.

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Abstract

The CdO and ZnO are n-type semiconductors are transparent conducting in nature, inexpensive, mechanically stable and highly resistance to oxidation. In the present work these films have been obtained from thermal annealing of chemically deposited CdS and ZnS thin films. The structural properties of chemically deposited CdS and ZnS thin films and thermally annealed CdO and ZnO thin films have been studied. From x-ray diffraction data it is observed that annealing of the thin films at a particular temperature enhance the structural properties.



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Introduction

CdO and ZnO is an n-type semiconductor belonging to II-VI group of periodic table. These materials possess wide band gap of approximately 2.4eV and 3.3eV at room temperature. These films are semitransparent in nature have been widely used in a flat panel displays, solar cells and gas sensing applications. These films are transparent conducting in nature, inexpensive, mechanically stable and highly resistance to oxidation¹⁻⁵. The CdS and ZnS thin films prepared by chemical bath deposition technique have been extensively studied by many researchers. In the present work we have attempted

to annealed CdS and ZnS films prepared by chemical bath deposition to form CdO and ZnO thin films.

The CdO and ZnO films obtained by annealing were characterized for investigation of structural properties. It is observed that annealing effect improve structure of thin films⁶⁻⁷.

Experimental

For the preparation of CdS and ZnS thin films chemical bath deposition technique were utilized. In this apparatus there is a facility for rotating the substrate, stirring the solution using the magnetic

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stirrer, change the temperature of the entire assembly and stabilized it at a particular value etc. In order to get uniform film thickness the film substrate is continuously rotated and the solution is continuously stirred using magnetic stirrer. The temperature of assembly is maintained by heating arrangement and temperature controller. The thickness of the films governed by controlling the deposition time and the concentration of the solution⁸⁻⁹⁻¹⁰.

The prepared samples of CdS and ZnS by chemical bath deposition were taken for annealing and kept into muffle furnaces Biotech of India of 2500 watts at 15 amperes which can withstand maximum temperature of 1000°C. The temperature of the furnaces was maintained at 600°C for more than 8 hours. After annealing sulfide ions converted into oxide ions by converting CdS into CdO and ZnS into ZnO¹¹⁻¹².

The prepared films of CdO and ZnO with annealing effect were taken for characterization to determine structural properties.

Result and Discussion

Figure 1 show the X- Ray diffraction pattern of CdS thin film obtained using X-Ray generated at 40kv energy and 15mA current without filter. SC 70 detector with the continuous scan mode was used. Qualitative Analysis Result shows that the Phase Name of the film is Greenokite with the formula CdS having DB Card number 1011054. The peak list of the CdS sample is shown in table 1^{13,14}.

The thermally oxidized CdO thin film were obtained by annealing the CdS as-deposited at 600°C for more than 8hours. The X- Ray diffraction data obtained for CdO thin film given in the table 2 and X- ray reflection peaks shown in figure 2 It is seen from the table2

Table 1: XRD data of CdS thin film

No.	2theta (deg)	d (ang)	Height (CPS)	FWHM (deg)	Grain size (nm)	Lattice strain
1	27.94	3.91	57	1.68	5.09	0.0295
2	32.25	2.774	72	4.9	1.76	0.074
3	52.67	1.736	99	0.59	15.7	0.0052

Table 2: XRD data of CdO thin film annealed at 600°C

Sr. No.	2theta (deg)	d (ang)	FWHM	Grain size (nm)	Lattice strain
1	29.32	3.043	0.164	52.32	0.0027
2	32.47	2.7545	0.163	53.04	0.0024
3	34.017	2.633	0.163	53.26	0.0023
4	49.23	1.849	0.163	56.01	0.0016

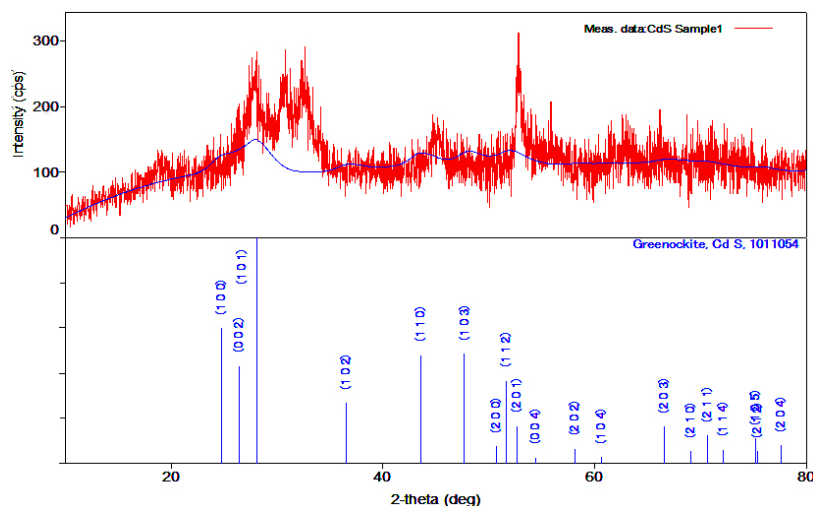


Fig. 1: X- ray Diffraction pattern of CdS thin film.

that the annealing temperature changes the grain size. The prominent reflection peaks are observed at the annealing temperature 600°C as seen in figure 2. The 2 θ values correspond to the particular reflection planes indicating the formation of CdO nanoparticle having pure hexagonal structure which matches with the standard JCPDF data^{15,16}.

The XRD pattern of the ZnS thin film was investigated by the Regaku Mimflex 600 Model X-ray diffractometer using PDXL software. This pattern explains the structural properties of ZnS film. The XRD pattern of ZnS sample as shown in figure 3 give three prominent peak at 2 θ values 32.620, 35.2950, and 37.0770. The d value 1.429Å, 1.333Å and 1.277Å respectively. These peaks are showing reflection from (100), (002) and (101) planes, indicating the

formation of ZnS nano-particles having cubic zinc blend structure. The enhanced intensity for the peak corresponding to (002) plane indicating preference orientation along c-axis. The peak list of ZnS sample is shown in Table 3.¹⁷

The X-Ray diffraction data obtained for ZnO thin film annealed at 600°C is shown in table 4. The prominent reflection peaks are observed with the reflection from (100) (002) (101) (102) (110) (103) seen in figure 4. This data indicates that annealed ZnO thin film is polycrystalline in nature having pure hexagonal structure as per the DB card number 2300113 and 9040180 respectively. The grain size obtained from the Debye-Scherrer's formula. It is found that average grain size is obtained which changes due to the change in annealing temperature^{18,19}.

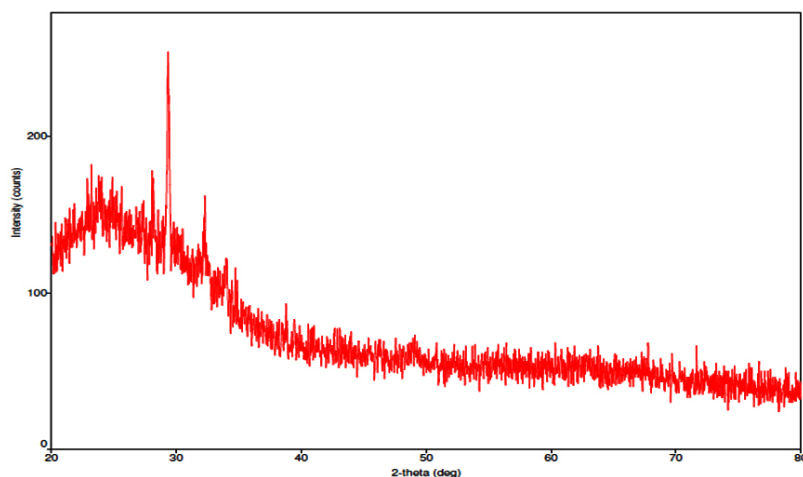


Fig. 2: XRD Pattern of CdO thin film annealed at 600°C

Table 3: XRD data of ZnS thin film

No.	2theta (deg)	d (ang.)	Height (cps)	FWHM (deg)	Grain Size (nm)	Lattice Strain
1	32.62	2.7428	416	0.22	39.31	0.0033
2	35.295	2.5409	642	0.199	43.76	0.0027
3	37.077	2.4228	729	0.262	33.44	0.0034
4	48.263	1.8841	159	0.27	33.69	0.0026
5	57.31	1.6064	128	0.37	25.56	0.003
6	63.55	1.4627	190	0.3	32.54	0.0021
7	68.56	1.3676	80	0.47	21.36	0.003

Conclusion

The thin film of CdO and ZnO successfully obtained by thermal annealing of CdS and ZnS at 600°C. X-ray diffraction analysis of the thermally annealed films CdO film shows that films are polycrystalline in nature. The prominent reflection peaks are observed at the annealing temperature 600°C. The 2theta values corresponds to the particular reflection planes indicating the formation of CdO

nanoparticle having pure hexagonal structure. The prominent reflection peaks are observed with the reflection from (100) (002) (101) (102) (110) (103) for ZnO thin film. This data indicate that annealed ZnO thin film is polycrystalline in nature having pure hexagonal structure. It is found that average grain size is obtained which changes due to the change in annealing temperature.

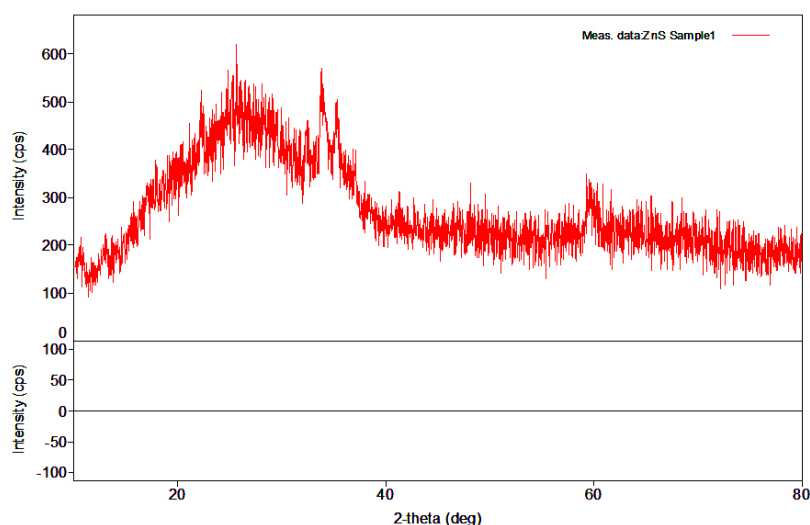


Fig. 3: XRD pattern of ZnS thin film

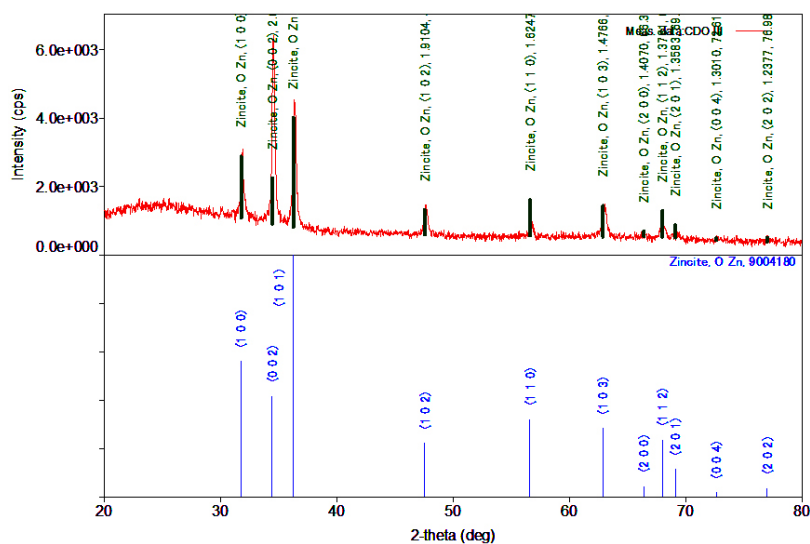


Fig. 4: XRD Pattern of ZnO thin film annealed at 600°C

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