INTERNATIONAL JOURNAL OF PHYSICS

ISSN: (Print)
ISSN: (Online)

Volume 1, Issue 1, January- March (2012), pp. 08-14
© IAEME: www.iaeme.com/ijp.html

IJP
©IAEME

ELECTRICAL PROPERTIES OF CHEMICAL BATH DEPOSITED CdS THIN FILMS

D Kathirvel [a*], N Suriyanarayanan [b], S Prabahar [c], S Srikanth [c]

a* Department of Physics, Kalaignar Karunanidhi Institute of Technology,Coimbatore

b Department of Physics, Government College of Technology, Coimbatore, India.

c Department of Physics, Tamilnadu College of Engineering, Coimbatore, India.

ABSTRACT

Thin films of CdS of different thickness have been prepared on glass substrates in various temperatures by Chemical bath deposition. Electrical resistivity measurements were carried out in four-probe vander pavu geometry at room temperature. Resistivity of CdS thin films is about $10^8 \Omega$cm. Typical linear dark I-V characteristics of the CdS thin films and ohmic behavior is observed.

Keywords: Electrical resistivity, Chemical bath deposition, CdS thin films, I-V characteristics.

INTRODUCTION

Chemical bath deposition is a well known deposition process for Chalcogenides such as Cd, Zn, Co, Hg, Pb sulphides and selenides [1]. The Chemical Bath Deposition (CBD) method, being less expensive than other thin film deposition methods allows for the manufacture of relatively low cost devices especially light detectors, light energy conversion cells and thin films field effect transistor [2, 3]. CdS in an important semiconductor material with very narrow band gap (2.10 to 2.40eV). The CdS material exhibits hexagonal structure with a preferred orientation along (002), (116,312) and (316,332) directions [4, 5]. In this paper we present the results of our studies on electrical studies of Chemical Bath Deposited CdS thin film.

EXPERIMENT

A simple Chemical bath deposition (CBD) method was employed to deposit CdS thin films on to glass substrates using thiourea as sulfide ion source and cadmium sulphate as cadmium ion source in Ammonia bath. For the preparation of CdS thin films, 110ml of water heated upto 70^0c and glass substrates was inserted and 0.0623M Cadmium sulphate was added with slow stirring of the precipitated solution. Ammonia solution (NH_3) was then added. When adding ammonia solution, the temperature of precipitated solution was reduced. Then 0.3284M Thiourea was added slowly in the solution. After adding thiourea, the precipitated solution became a yellowish colour which indicates the production of Cadmium sulfide in the precipitated solution. Time taken for the growth of the Cadmium Sulfide on the glass substrates varied from 30 minutes to 45 minutes. Substrate cleaning plays an important role in the deposition of thin films. Commercially available glass micro slides were submerged into the chromic acid for upto 2 to 3 hours. Then the glass substrates are washed with detergent and finally rinsed with acetone before use. The films with different thickness were obtained by varying the deposition time period. The thickness of the CdS thin films are measured by using gravimetric method [6, 7]. The thickness variation of successive film is in the range of 90 Å in $CdSo_4$ combination. The nature of the electrical properties was examined by four-probe vander pavu geometry at room temperature. The arrangement consists of PID controlled oven (Model PID-2000, Scientific Equipment and services, Roorkee, India). The thickness dependent current-voltage behavior of Schottky devices was studied using Janis Liquid Nitrogen VPF Series Cryostat. Rotary pump was used to maintain desired vacuum inside the cryostat.

RESULT AND DISCUSSION

RESISTIVITY STUDIES

In semiconductor industry the most generally used technique for the measurement of resistivity is the Four- Point Probe. Current is passed thought the outer two probes and the potential developed across the inner two probes. Further, it is after convenient to present the current to 2πS milliamperes or microamperes so that the resistivity in ohm-centimeters will be numerically equal to the measured voltage in milli-or micro volts, respectively.

Fig. 1. Fig.2. and Fig.3. show the variation of log ρ against reciprocal of temperature (1000/T) with different thickness of 560Å, 1180 Å & 1700 Å is measured using the d.c. four probe method in air.

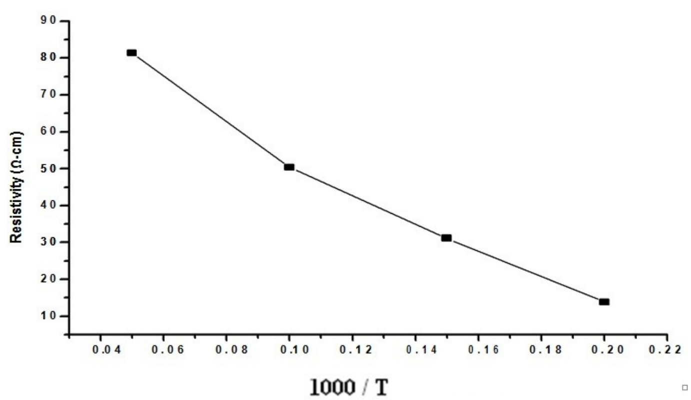

Fig. 1. Resistivity Vs (1000/T) of CdS thin film at d = 560 Å

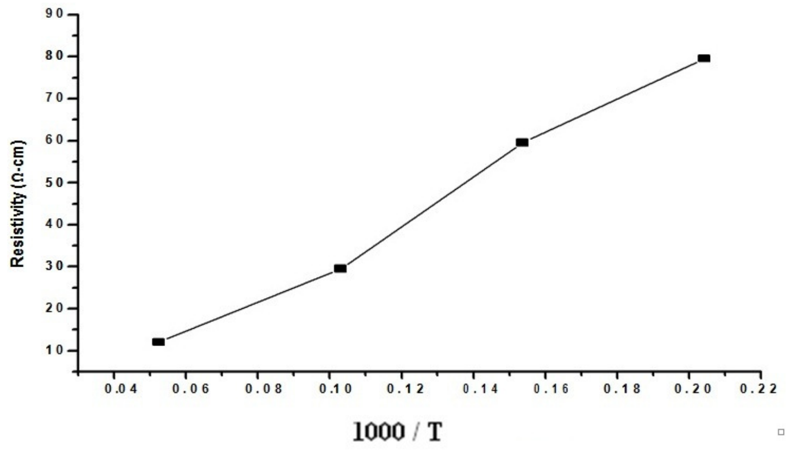

Fig. 2. Resistivity Vs (1000/T) of CdS thin film at d = 1180 Å

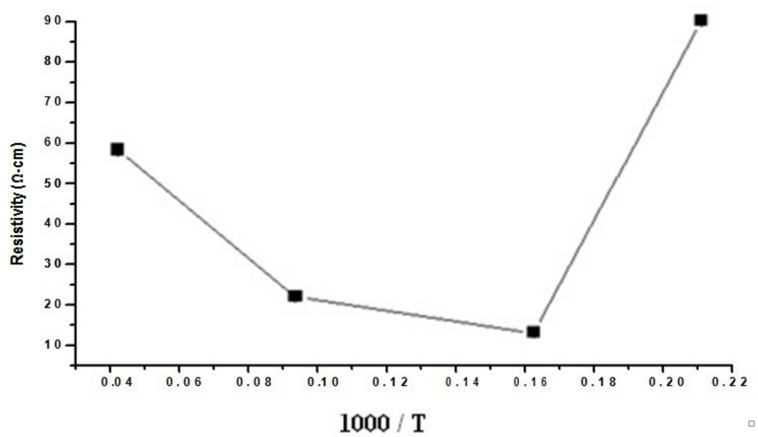

Fig. 3. Resistivity Vs (1000/T) of CdS thin film at d = 1700 Å

From the resistivity plot, the variation of resistivity and activation energy at different thickness of CdS films are shown in Table 1.

Table 1. Variation of resistivity and activation energy with different thickness

Sl. No.	Film thickness (Å)	Resistivity (Ω cm)	Activation energy (eV)
1	560 Å	2.54×10^6	0.6403

2	1180 Å	3.28×10^6	0.7498
3	1700 Å	9.87×10^6	0.7874

The resistivity of as deposited CdS thin film obtained by chemical bath deposition at room temperature is too high. Table 1. shows activation energies at different thickness of CdS film. Activation energies are in the range of 0.6345 eV to 0.7095.

I-V Characteristics of CdS thin films.

The I-V characteristic without illumination (in dark), the forward current of the cell increases slowly with increasing voltage is shown in Fig. 4. over the CdS thin films of thickness 560 Å, 1180 Å and 1700 Å.

The short circuit current I_{SC} corresponds to the short circuit condition when the impedance is low and is calculated when the voltage equals 0.

$$I \text{ (at } V=0) = I_{SC} \qquad \text{----------------} \qquad (1)$$

From the Fig. 4, the heterojunction has rectification properties and the current increases with increasing thickness. Since the dark I - V plots are similar to the diode characteristics. I_{SC} occurs at the beginning of the forward-bias sweep and is the maximum current value in the power quadrant.

$I_{SC} = I_{MAX} = I_{\ell}$ for forward-bias power quadrant.

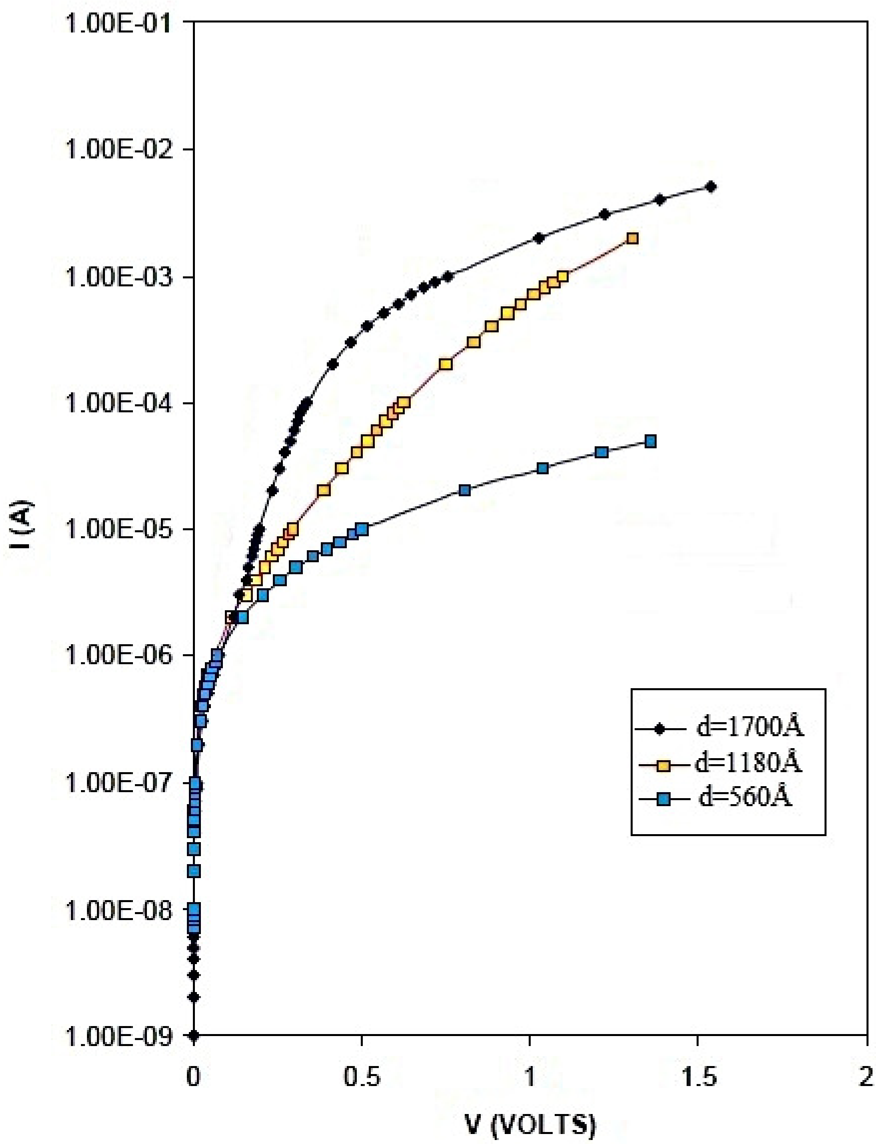

Fig. 4. I - V characteristics of CdS thin films in dark condition at different thickness by Chemical bath deposition.

The open circuit voltage (V_{OC}) occurs when there is no current passing through the cell.

$$V\ (\text{at } I=0) = V_{OC} \qquad \text{----------------} \qquad (6.4)$$

V_{OC} is also the maximum voltage difference across the cell for a forward-bias sweep in the power quadrant.

$V_{OC} = V_{MAX}$ for forward-bias power quadrant

The power produced by the cell in Watts can be easily calculated along the I-V sweep by the equation $P=IV$. At the I_{SC} and V_{OC} points, the power will be zero and the maximum value for power will occur between the two. The voltage and current at this maximum power point are denoted as V_{MP} and I_{MP} respectively.

CONCLUSION

CdS thin film has been deposited on a well cleaned glass substrate by chemical bath deposition technique. CdS shows n-type conductivity. Its resistivity is about $10^8\ \Omega$ cm. Carrier concentration is found to improve with Cd concentration in bath. Conductivity is found to improve with dosage. High resistivity is due to low-deposition temperature and as a consequence of that the film formed with a small grain size and thus contains many grain boundaries which in turn increase the resistivity. Through the hot point probe technique the film shows n-type conductivity. From the resistivity plot, the variation of resistivity and activation energy at different thickness of CdS films can be calculated.

CdS exhibits characteristics compatible with window material for solar cells.

REFERENCES

[1] R.S. Mane, C.D. Lokhande, Thin solid films.65,1 (2000).
[2] J.H. Schon, O.Schenker, B.Battogg, Thin solid films, 385,271 (2001).
[3] A.Davis, K.Vaccaro, H.Dauplaise, W.Waters, J.Lorenzo, J.Electrochem.Soc.146, 1046 (1999).
[4] Sushilkumar, Zishan.H.Khan, M.A. Majeed Khan, M.Husain, Current Applied Physics.5, 561 (2001).
[5] J.Dona, J.Herrero, J.Electrochem.Soc, 139, 2810 (1992).
[6] H.Metin, R.Esen, Semicond.Sci.Technol, 18, 647 (2003).
[7] I.Oladeji, L.Chow, J.Electrochem. Soc, 144, 2342 (1997).

*Corresponding author: kathirvelde.5@gmail.com