Characterization Studies of CdS Nanocrystalline Film Deposited on Teflon Substrate

Lekha Verma[1], Dipali Soren[2], Sandhya Pillai[3], Prashant Shrivastava[4]

[1, 2, 4] *ETC Department, CCET Bhilai, India*
[3] *PHYSICS Department, CCET Bhilai, India*

Abstract:- **In this article, different substrates for deposition of CdS material have been discussed. Till date glass, mica, quartz, ceramic, etc. are commonly employed substrates in thin film growth. In the present work, CdS is deposited on Teflon substrate by chemical bath deposition (CBD) method. Also the films were deposited on different substrates like glass, copper and zinc and compared with those prepared on Teflon substrate. The films prepared on Teflon substrate were uniform, stable and also showed good radiating property. These films were further characterized by UV-VIS absorption spectral studies, SEM and EDS studies.**

Keywords: **Teflon, CdS, SEM, substrate**

I. INTRODUCTION

The deposition of thin films require certain supporting materials called substrate. Substrate may be amorphous, polycrystalline or single crystal in nature. Glass, mica, quartz, ceramic, etc. are commonly employed substrates in thin film growth. Recently, efficient polycrystalline films are being deposited on polymer substrates, such as polycarbonate and polyethylene terephthalate as they are light weight, of small volume and can make the obtained devices foldable and also easy to carry [1]. Cadmium sulfide, CdS is a II–VI semiconductor compound. It is a wide and direct band gap (2.42 eV) material at room temperature and has good optical transmittance, low resistivity and easy ohmic contact. CdS surface quality depends on the method used for film preparation, and also requires that the films be free of voids, grain frontiers, etc., and to be capable to achieve minimum thicknesses to reduce optical losses. [2]

CdS material has been synthesized by different techniques like CBD, Sputtering, Electro chemical deposition etc. This material shows interesting optical and electrical properties and hence is used in solar cells, as pigment, photovoltaic devices, and sensors.

Nanocrystalline materials are becoming increasingly interesting for optoelectronics and photonics. The electronic and electrical properties of such materials show a remarkable change as the particle size approaches that of its excitonic Bohr radius and then electrons and holes are subject to quantum confinement effects [3, 4] due to their large surface to volume ratios resulting in high density of surface states. These nano particles with tailored physical properties have potential application in the fields of molecular level electronic and photovoltaic devices [5], [6], catalysis, molecular diagnostics and interfacial electron transfer [7] This paper mainly focus on different substrate study and properties of CdS material.

II. MATERIALS AND METHODS

Thin films were deposited on teflon substrate (22mm L × 16 mm wide), thickness 1.5 mm (±0.1 mm) with dielectric constant of 2.1. The teflon substrates were first washed with concentrated HCl and acetone .After that the slides were thoroughly washed by deionized water several times, For the bulk CdS film, 1M Cadmium Acetate Triethanolamine, Thiourea and aqueous Ammonia were added. For the nano crystalline film, mercaptoethenol (MEL) as capping agent and methanol (used for dissolving MEL) were added. In the beginning when precipitation started, stirring was done using magnetic stirrer for 5min. After that the deposition was made in static condition in the water bath at temperature 60^0C. During which the solution color changed to yellow as the deposition time increases. At the end of the deposition, CdS thin film was formed on the substrates with desired thickness, was adherent, homogeneous and yellowish without any powder precipitation. The substrates were removed from the chemical bath, rinsed thoroughly in distilled water and dried in the air at room temperature.

The surface morphology and chemical composition of the films were analyzed by scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDS) using S-48500 type-II (Hitachi High Technology Corporation Tokyo, Japan). The optical properties of the films were determined by ELICO SL210 UV-VIS Spectro photometer.

Fig 1 deposition of CdS on Teflon substrate

III. RESULT AND DISCUSSION

3.1. Substrate studies

CdS was deposited onto different substrates. Substrate may be amorphous, polycrystalline or single crystal in nature. Glass, mica, quartz, ceramic, etc. are commonly working substrates in thin film growth. Ideally substrate should have the following requirements [8]

- The surface should be flat and smooth.
- Substrates have high mechanical strength, high resistivity and high thermal conductivity.
- To minimize thermal stress, substrate should have nearly same coefficient of thermal expansion with that of the film.
- Low cost.
- For proper adhesion of the films and for producing reproducible film properties, the substrates should be highly cleaned and unpolluted.
- Usually the common impurities are the fine dust particles due to packaging, fingerprints and sticking of different contamination atoms. The removal of these contaminants by different cleaning techniques depends upon the nature of the substrate and the type of contaminants.

Firstly CdS was deposited on different substrates and it was found that the films deposited on Teflon were uniform, stable and also showed good radiating property as compared to glass, zinc and copper.

3.1.1 Copper substrate

Copper plate is mainly a mechanically support and electrically connects electronic components using conductive tracks, pads and other features etched from copper sheets laminated onto a non conductive substrate. Components- capacitors, resistors or active devices are generally soldered on PCB [8] .When we deposited CdS material on to PCB substrate by CBD method for one hour, film showed uniform deposition. But after one day the surface of copper substrate was oxidized or reacted with the environment. and the colour was changed from yellow to yellowish brown as shown in fig.2. hence we could not use this substrate for our work

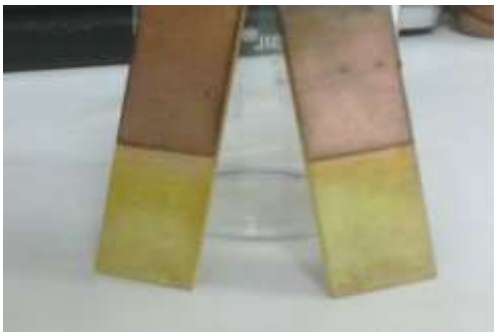

Fig.2. after deposition of CdS onto copper substrate

3.1.2 Zinc substrate

Zinc is now the fourth-most widely consumed metal in the entire world. Nearly one half of all zinc produces is used in zinc galvanizing processes to protect steel and iron from rusting. This involves coating the surface of a metal with a thin layer of zinc to create a corrosion- resistant barrier [8]. When we deposited CdS material on to zinc substrate by chemical bath deposition method, then after 1 hour it started to dissolve into the solution and color of precipitate turned from yellow to black. In case of zinc substrate, it reacted with CdS and the film turned black. Fig 3 shows the film deposited onto zinc substrate

Fig.3 after deposition of CdS onto zinc substrate

3.1.3. Teflon substrate

Scientifically teflon is called polytetrafluroethylene (PTFE) that has numerous applications.Teflon was discovered by Roy J. Plunkett (1910-1994) in 1938 and was used as a commercial product in 1946. Structurally there are different types of Teflon. However, the most popular and applicable form of Teflon is PTFE; a polymer with repeating chains of CF2-CF2 [8]. Finally Teflon was used in which uniform CdS film was deposited and it showed excellent radiating property.

3.2.Surface morphology and compositional studies: Fig.4 a and b shows SEM image of as-deposited cadmium sulphide thin films on Teflon substrate. It shows that the substrate is well covered with the deposited material without cracks. The scanning electron microscopy (FE-SEM) study for CdS films on the teflon substrate reveals that the surface is a layered structure with clusters of spherical particles.

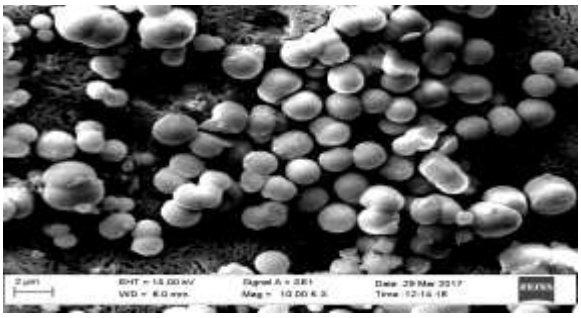

Fig. 4a

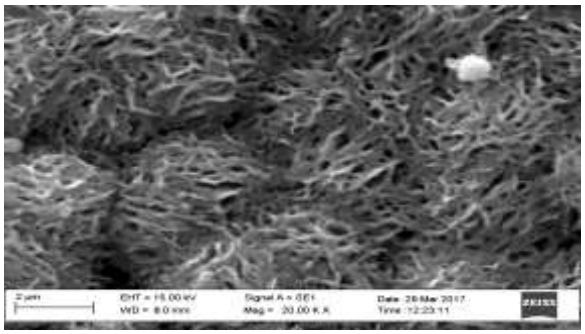

Fig.4b

Fig 4a & b: SEM image of CdS deposited on Teflon substrate

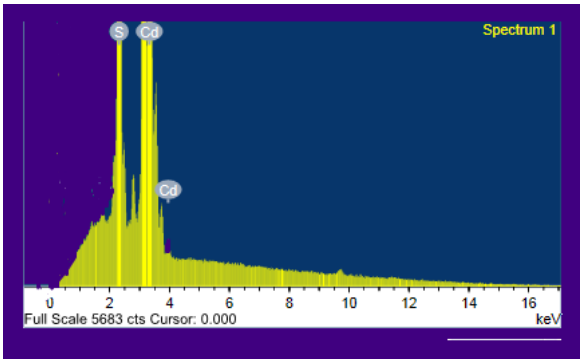

Fig.5 EDS spectra of synthesized CdS nano particle deposited on Teflon substrate

The elemental analysis of CdS thin films deposited on Teflon substrate was performed using EDS analysis and presented in fig.5. EDS spectra shows the presence of Cd and S peaks thus confirming the formation of pure CdS with no other elemental impurity.

3.3 Optical studies:

In order to obtain the information regarding the optical bandgap and the nature of transition involved, the optical properties of the CdS nanocrystalline thin films were studied using the UV-VIS spectrophotometer at room temperature. Fig. 6a & b shows the optical absorption spectra of CdS thin films in the wavelength range of 300-700nm.

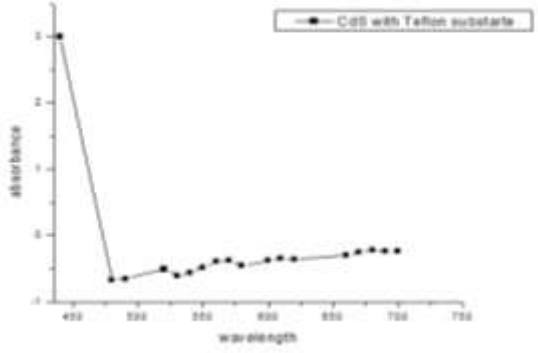

Fig.6a

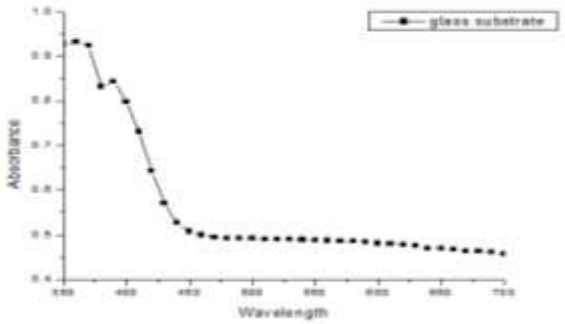

Fig.6b

Fig.6a& b Absorption spectra of CdS on glass and Teflon substrate

The band edge in both cases was around 450nm. However absorbance was less in the case of Teflon substrate.

IV. CONCLUSION

The salient conclusions arising from this study are summarized below:

1. CdS nanocrystalline film is deposited on different substrates. Teflon was found to be a better substrate to study radiating property.
2. Excellent adherence, uniform deposition, homogeneous morphology on Teflon substrate is confirmed by SEM analysis.
3. EDS analysis showed that Cd rich CdS thin film has been deposited on Teflon substrate.
4. Optical absorption study revealed direct bandgap nature.

ACKNOWLEDGEMENTS

Authors are grateful to the Head, Department of Material Science, National Institute of Technology Raipur for providing facilities for SEM and EDS.

REFERENCE

[1]. K. Wasa in K.L. Chopra and L.K. Malhotra (edn.); "Thin Film Technology and Applications", Tata McGraw-Hill, New Delhi, 1985, pp. 27-50.
[2]. A.I. Oliva , R. Castro-Rodr´ıguez, O. Ceh, P. Bartolo-Pe´rez 1, F. Caballero-Briones ,V´ıctor Sosa, "First stages of growth of CdS films on different substrates", ELSEVIER , Applied Surface Science 148 _1999. 42–49
[3]. L.E. Brus , J Chem. Phys. 90 (1986) 2555.
[4]. G. Wakefield, H.A. Keson, P.J. Dobson, J.L. Hutchison, J. Phys and Chem. of Solids 60(1999) 503.
[5]. Gogotsi, Y.: Nanomaterials Handbook; CRC Taylor & Francis Group, LLC: United States of America, 2006.
[6]. Liu, J., Sheina, E., Kolawlewski, T. and Mccullough, R.D. (2002) Angewandte Chemie International Edition, 41, 3259.http://dx.doi.org/10.1002/1521-3773(20020902)41:17<3259::AID-ANIE3259>3.0.CO;2-B
[7]. Greenham, N.C., Peng, X.G. and Alivisatos, A.P. (1996) *Physical Review B,* 54, 17628. http://dx.doi.org/10.1103/PhysRevB.54.17628
[8]. http://wikipedia.org