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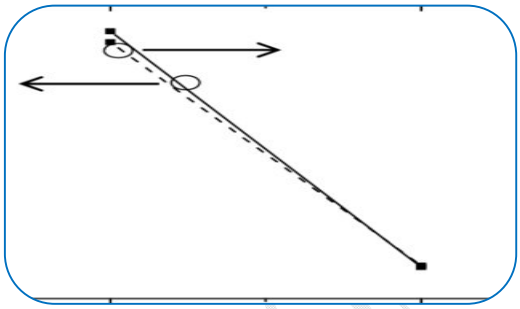
SYNTHESIS AND CHARACTERISATION OF CdS THIN FILM BY CHEMICAL BATH DEPOSITION METHOD



Miss. Arati Dattatray Sutar ,
Mr. Chaudhari Swapnil Balu and
Miss. Diveker Yogita Balasaheb.
Bhairavnath Vidnyan Mahavidyalay Khutbav,
Tal-Daund,Dist-Pune,

ABSTRACT :

Cadmium sulphide (CdS) thin films synthesized by chemical bath deposition CBD by using UV visible absorption spectrum. The optical band gap of the semiconductors is an important parameter plays a major role in the construction of photovoltaic cells.In the present work the optical properties of CdS deposited on glass substrate.The optical properties of a structure using the visible absorption spectrum and its shows band gap energy of thin film 2.42 eV.

KEYWORDS : *CdS thin film,UV-analysis.*

INTRODUCTION

Cds thin film can be produced by different methods such as pulse laser deposition, spray pyrolysis, sol-gel technique, chemical bath deposition. The films in this study are grown by chemical bath deposition which creates a thin film on the solid substrate via a reaction in liquid solution. CBD method is inexpensive, easy to prepare and its necessary vessel can be found in an ordinary chemistry laboratory.

A good candidate as an alternative material is the semiconductor CdS because it has strong surface sensitivity. It has direct band gap of 2.42 eV at room temperature and has a large exciton binding energy which is necessarily adequate to overcome the thermal energy at room temperature

LITERATURE SURVEY OF CdS:

The detailed survey of literature of Cadmium Sulphide thin film with different deposition technique and CBD technique. The aim of literature survey is to understand relevant experience during synthesis of thin films, with its promising application as well as unsolved problems.

Different techniques to prepare the Cadmium sulphide thin film have been reported in the literature such as a thermal evaporation spray pyrolysis, and sputtering. Among the previously mention techniques, chemical bath deposition emerge as the promising, simple and low cost technique to prepare uniform and scalable thin film. CBD is an attractive technique which brings the possibility of controlling the zinc oxide films thickness and crystalline, by means of the continuous deposition of multilayer for optical and solar devices.

THIN FILM

A thin film is a layer of material ranging from fractions of a nanometer(monolayer) to several micrometres in thickness.Thin films are created through a process called “deposition”.Diposition is a thin film coating process, which is achieved by modifying the four states of matter solid, liquid, vapour

and plasma. This can be accomplished through variety of physical and chemical processes. Thin films are ubiquitous. Some applications benefiting from thin film technology and electronic Semiconductor devices.This includes Integrated circuitchips,micro-fabricated mechanism,micro- electrochemical systems (MEMS) micro-electronic optical systems as well as light emitting diodes (LEDs). Other mainstream application include optical coatings,photovoltaic solar cells and thin film batteries. The performance of thin film optical coatings (e.g.anti-reflective or AR coatings) is typically enhanced when the thin film coating consists of multiple layers having varying thicknesses and refractive indices. Similarly, a periodic structure of alternating thin films of different materials may collectively form a super lattice, which exploits the phenomenon of quantum confinement by restricting electronic phenomena to two dimensions. Ferromagnetic and ferroelectric thin films are used as Computer memory. Slight film innovation is being investigated as a way to generously decrease the expense of photograph voltaic frameworks, which are utilized to gather sun oriented vitality. Slim film batteries can be kept onto contributes any shape or measure or can be adaptable and imprinted on to plastic, slender metal or paper utilizing dainty film printing innovation. A common use of thin film technology is in the manufacture of reflective, anti-reflective or self-cleaning glass , CdS is an important Group II-lV semiconductors material. It has attracted a great interest in electronic and optoelectronic devices. It is a promising material for visible light detection because of its intermediate energy band gap of 2.42 eV and high photo sensitivity, CdS is widely used as a layer for both CdTe and CuIn(Ga)Se2 thin film solar cells. It also has been used in various electronic devices to passivate services CdS has good thermal stability, light fastness, chemical resistance and high opacity, make it as a potential material for optoelectronic applications.

- **Electrical Property**

Dielectric constant	8.9
Electron Mobility	350 cm2/ Vs
Hole Mobility	40 cm2/Vs
Band Gap	2.42 eV

- **Thermal properties**

Thermal Expansion coefficient	H=6.26×10^-6 /K C=3.5×10^-6 /K
Thermal conductivity	40.1 W/Mk

- **Mechanical property**

Melting point	1750
Boiling point	980
Density	4.826 g/cm3

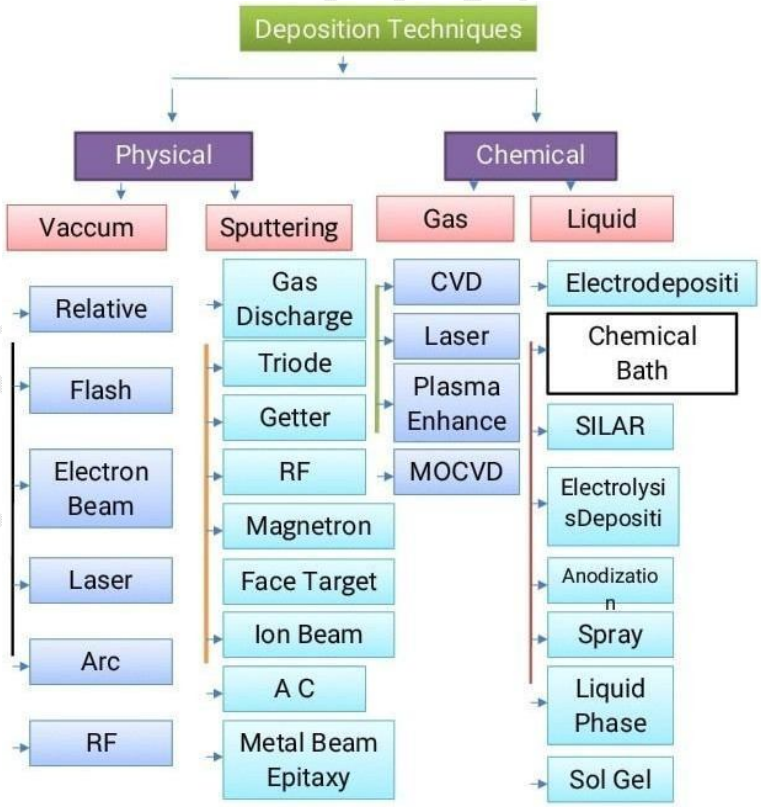
- **Optical property**

Refractive Index	2.529

PHYSICAL PROPERTIES

- The conductivity increases when irritated,(leading to uses as a photoresister)
- When combined with a p-type semiconductor it forms the core component of a photovoltaic (solar) cell and CdS/Cu2S solar cell was one of the first efficient cells to be reported (1954)
- When doped with for example Cu+ ("activator") and Al3+ ("coactivator") CdS luminance's under electron beam excitation (cathodoluminescence) and is used as phosphor.
- Both polymorphs are piezoelectric and the hexagonal is also pyroelectric.
- electroluminescence
- CdS crystal can act as a solid state laser
- In thin film form, CdS can be combined with other layers for use in certain types of solar cells. CdS was also one of the first semiconductor material to be used for thin-film transistors(TFTs).However interest in compound semiconductors for TFTs largely waned after the emergence of amorphous Silicon Technology in the late 1970s.
- Thin films of CdS can be piezoelectric and have been used as transducers which can operate at frequencies in the GHz region.
- Nanoribbons of CdS show on net cooling due annihilation of phonons, during anti-stokes luminescence at ~510 nm, As a result the maximum temperature drop of 40 and 15 K has been demonstrated when the nanoribbons are pumped with a 514 or 532 nm laser.

THIN FILM DEPOSITION TECHNIQUES



1. Spray pyrolysis:

Spray pyrolysis is well established and widely used technique for the film processing. It is a chemical vapour deposition that has been successfully used for the position of the various oxides best material. Two major interest in this method are operating at atmospheric pressure and deposition on the large surface. It is quite simple method due to use of air without vacuum system which is mostly used in the other technique. The spray deposition is based on the mechanical transformation of the solution to droplets team by using compressor gas ultrasonic waves. Basically pyrolysis is chemical reaction. This reaction in involves molecular breakdown of large molecules into smaller molecules in the presence of heat.

2. Physical vapour deposition:

Physical vapor affidavit depict an assortment of vacuum statement technique which can be utilized to deliver think and coatings. PVD is the portrayed by the procedure in which the material do goes from considered stage to a vapor stage and after that back to thin film consolidated stage. The most widely recognized PVD procedure or sputtering and dissipation. PVD is utilized in the assembling of things which required in slender film for mechanical, optical, compound or electronic capacities. Model incorporate semiconductor gadgets, for example, dainty film sun oriented board, aluminized PET film for nourishment pressing and inflatables and covering cutting apparatuses for the metal working. Other than PVD apparatuses for creation exceptional littler to have been created.

3. Ionized cluster beam deposition:

This method is useful to obtain single crystalline thin film. The setup consists of the source of evaporation. Nozzle(material to be deposited) electron beam to ionized cluster and arrangement to accelerate the cluster a substrate and vacuum chamber.

Small cluster from molten material are expanded through the fine nozzle. The nozzle diameter should be larger than the mean free path of the atoms or molecules in the vapour to from the cluster one collision with electron beam cluster get ionized. the cluster are directed towards the substrate by applying accelerate voltage. the energy can be control with controlling the accelerated voltage. Stable cluster of some material may require considerable energy to break their bonds and prepare to remains as small cluster of properties. Does we can get the film as nanocrystalline material using ionizing cluster beam.

4. Sputtering deposition:

Sputtering is process particle are affected from solid target material due to bombardments of a target energetic particle. sputtering deposition is physical vapour deposition method of a thin film deposition by sputtering. Sputtered atom ejected from the target have energy up to eV (100000k). The sputtered particles can fly from the objective in straight lines vivaciously on the substrates. At higher gas weight particles colloids with gas molecules go about as a mediator, achieving the substrates or vacuum chamber divider. The entire range from higher energy baluster compact to lower energy thermal list motion is assemble by changing the background gas pressure. Sputtering gas is inactive gas, for example, argon. Nuclear load of sputtering visitor ought to be near the nuclear load of the objective for sputtering light neon, krypton or xenon are utilized. Responsive gases can likewise be utilized to spotter mixes. main parameters. Sputter affidavit make it a mind boggling process auto master a vast level of power over the development and microstructure of the film.

5. Sol - gel deposition :

Sol - gel is a chemical solution process used to make ceramics and glass material in the form of thin film fibre or powder. A sol is a colloidal or molecular suspension of a solid particles of iron in a solvent. The particle may be amorphous or crystalline. A gel is a semi rigid mass that forms when the solvent from the sol begins to evaporate. It can produce thick coating to provide corrosion protection performance.

6. Chemical vapour deposition:

Chemical vapour deposition is a chemical process is used to produce high quality, high performance, solid material. Substance vapor statement by and large employments of gas stage forerunner, regularly a halide or cross breed of component to be stored. On account of MOCVD and natural metallic gas is utilized. Business strategies of 10 utilizes low weight of a forerunner gas. Generally use CVD to store material in different structures including: nanocrystalline, polycrystalline, shapeless, and epitaxial. This materials include: silicon, carbon, fluorocarbons, tungsten and titanium nitride and various high k dielectric.

METHODOLOGY

CHEMICAL BATH DEPOSITION

Considering the current interest in nanostructured materials because of their potential application prospects,CBD has been extensively utilized for the synthesis of nanostructured semiconductors because of the low cost synthesis route and high production scale.

CBD is the most common solution process used to deposit CdS thin films. Chemical deposition refers to the deposition of thin films on a solid substrate from.a reaction occurring in an aqueous solution.

CBD is the experimentally simplest method in chemistry and material synthesis as it do not require sophisticated instrumentation and other expensive equipment.The chemicals used in the synthesis process are commonly available and cheap.Morever, high temperature is not required.the reaction between the dissolved precursors occurs generally in aqueous solution at low temperature(30C^{o} to 80 C^{o}.). Various substrates such as insulator , semiconductors,or metals can be used since these are low temperature processes,that prevent oxidation and corrosion of the substrate.CBD is not a new technique;it originated more than a century ago. 19 as early as 1835,leibig reported the disposition of thin film silver mirrors for the first time using the technique.In 1884, Emerson-Reynolds reported the disposition of PbS films from aqueous solution of TU and alkaline lead tartrate.CBD was then essentially limited to PbS and PbSe for a long time until 1961 when CdS thin films were explicitly reported by Nourishing et all.The range of materials deposited by CBD was gradually expanded, particularly in the 1980s,to include a large number of semiconductors of metals chalcogenides due to their potential in optoelectronic applications Chemical deposition received a major impetus after CdS was used a Window layer for CdS/CdTe and CdS/CuInSe2 thin film-based solar cells[6].It has been found that CdTe and CuInSe2-based solar cells showed superior photovoltaic performance with the CBD-CdS thin films compared to evaporated CdS[6]. Therefore,the CBD method allows for the manufacture of relatively low cost devices, especially light detectors and light energy conversion cells.However,few studies reported on the growth of CdS thin films on Si substrates by the CBD technique.

CdS thin films grown on Si substrates by the CBD technique are of low crystallinity and poor quality,which limit their use in certain applications.

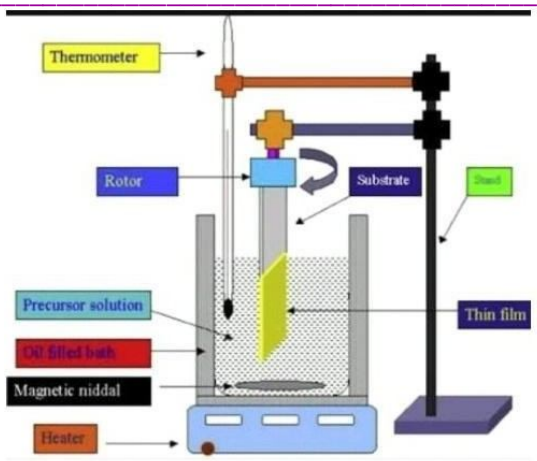


Fig. Schematic diagram of chemical bath deposition method

- **ADVANTAGE OF CBD TECHNIQUE:**

The major advantages of CBD is that it require in its simplest form only solution container and substrate mounting devices. One of the drawbacks of this method is wastage of solution after every deposition. Chemical bath deposition yields stable, adherent, and uniform and hard films with good reproducibility by a relatively simple process. The growth of champions strongly depends on growth conditions, such as duration of deposition, composition and temperature of the solution, and topographical and chemical nature of substrate.

SYNTHESIS

SUBSTRATE CLEANING:

The glass substrates where clean and ultrasonic cleaner using Acetone and alcohol and they were shocked in an chromic acid cleaning solution for 20 min. Further,they were cleaned ultrasonically in and isopropyl alcohol.Finally, they were washed in deionized water and dried by flowing with dried nitrogen for 30 min.

EXPERIMENTAL:

Thin films of CdS were deposited from the solution by using high purity start materials (Sigma aldrich) cadmium Chloride(CdCl2) as a Cd2+ ions source,Ammonium fluoride (NH4F), thiourea[SC(NH2)2] as a s-2source in an alkaline solution of ammonia [NH3] as a complexing solution.

Results and Discussion

General formula:

Total weight=[mol.wt.×Molarity×wt.of solution(ml)]/1000
1]Wt. Of Cadmium Chloride[CdCl2]=201.32*0.1*40/1000=0.80528 gm
2]Ammonium fluoride[Nh4F]=37.04*1*10/1000=0.307gm
3] Thiourea[SC(NH2)2]=76.12*1*8/1000=0.6089 gm.

The Thin film is prepared by following steps:

1. Prepare 40 ml solution of cadmium chloride (0.1M) for the sample.
2. Prepare 10 ml solution of Ammonium fluoride(1M) for the sample.
3. Prepare 8 ml solution of thiourea(1M) for the sample.
4. Take 40 ml solution of CdCl2 in 100 ml beaker and Put the beaker on magnetic stirrer to stir the solution continuously.
5. Add 10 ml solution of Ammonium fluoride.
6. Add ammonia drop by drop in it then it starts to become milky.Continuous adding ammonia in the solution till the solution becomes clear.
7. Add 8 ml thiourea in it & dilute whole solution upto 80 ml.
8. Then dip glass substrate & thermometer in the solution for measuring temp.upto 75 . .
9. After 45 min.remove the glass substrate from the solution & wash with distilled water.
10. Thin film kept in protective environment.
11. The Ph of the solution is about 10.21.

Precursors =CdCl2+NH4F+Thiourea,Ammonia(NH3)=5.8 ml.

°C

Fig.Thin Films Of CdS

UV-VISIBLE SPECTROSCOPY

UV-visible spectroscopy or ultraviolet-visible spectrophotometer (UV-Vis or UV-/Vis) refers to absorption spectroscopy or reflectance spectroscopy in the ultraviolet- visible spectral region. This means it uses light in the visible and adjacent (near-UV and near-infrared [NIR]) ranges.[clarification needed] The absorption and reflectance in the visible range directly affects the perceived color of the

chemicals involved. In this region of the electromagnetic spectrum,atoms and molecules undergo electronic transition. Absorption spectroscopy is complementary to fluorescence spectroscopy,in that fluorescence deals with transitions from the excited state to the ground state, while absorption measures transitions from the ground state to the excited state.Molecules containing π-electrons or non-bonding electrons (n-electrons)can absorb the energy in the form of ultraviolet or visible light to excite these electrons to higher anti-bonding molecular orbital's. The more easily excited the electrons (i.e. lower energy gap between the HOMO and LUMO).

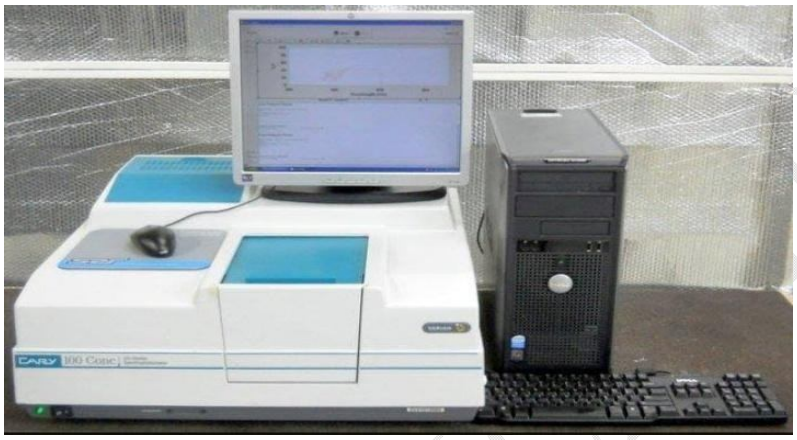
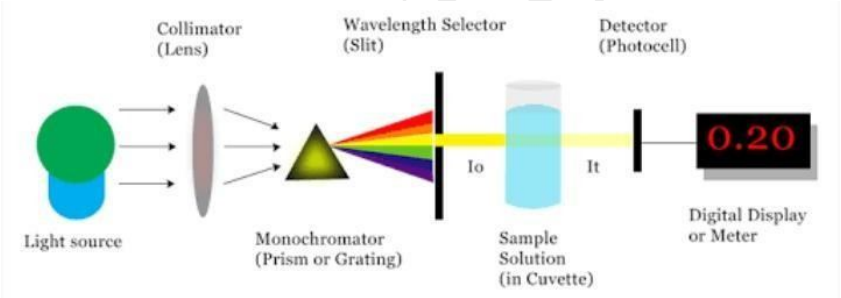


Fig.UV-Visible Spectroscopy Instrument



BAND GAP ENERGY

The Optical band gap of energy of the semiconductors is an important parameter that plays a major role in the construction of photovoltaic cells.In the present work the Optical properties of CdS deposited on glass substrate were studied from the absorption spectrum in the wavelength ranging from 300 to 800 nm. The sharp absorption edge observed confirms the good optical band edge property of the CdS thin film.

The band energy calculated by using following equation

1240/lambda=*hv*

(ahv)2=hv=band gap energy.

Where A is the constant,*hv* is the photon energy & *Eg* is the optical band gap A plot of variation of(*ahv)2* verses *hv* is shown in fig. Where *a* is the optical absorption coefficient & *hv* is the photon energy.*Eg* was evaluated using the extrapolation of the linear portion of the curve to photon energy axis for zero absorption coefficients,the intercept of the curve i.e. the optical band gap of CdS thin film was estimated & found 2.3 eV.

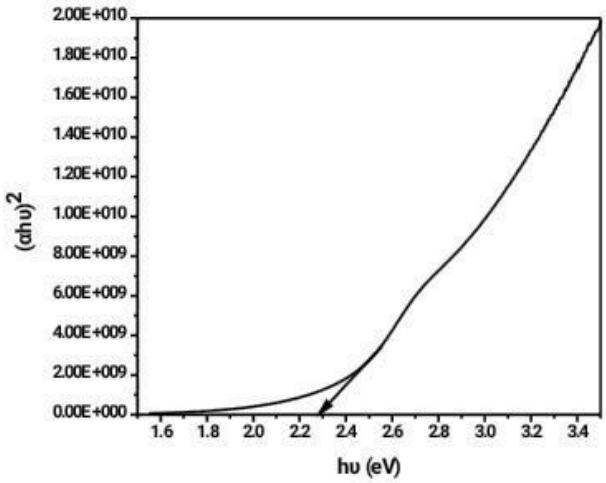


Fig.BAND GAP OF CdS THIN FILM

CONCLUSION

. CdS Thin Film is successfully synthesized by the chemical bath diposition process
. The band gap of CdS thin film is 2.3 eV.

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