CU DOPPED ZnS THIN FILMS BY CHEMICAL BATH DEPOSITION METHOD AND ITS CHARACTERIZATION

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ABSTRACT

Copper and ZnS doped zinc sulphide thin films are equipped through chemical bath deposition method (CBD). To find out the UV, XRD analyses are carry out. The linear nature of absorption indicates that ZnS (CU) is a direct band gap substance with the band gap energy equal to 0.3eV. The XRD image of the ZnS (CU) thin film gibes the in progression about the crystalline configuration prepared thin film. It confirms that the film has hexagonal crystalline structure.

Keyword: chemical bath deposition method (CBD), UV, XRD, ZnS (CU) thin film

INTRODUCTION

Zinc Sulphide (ZnS) is a wide-band-gap semiconductor and n-type conductivity which crystallizes in both cubic and hexagonal forms, with a range of potential applications in optoelectronic devices, such as electroluminescent devices and photovoltaic cells. It is an outstanding host material for electroluminescent phosphors and is being commercially used in emitting layers for electroluminescent displays[1,2]. In the opto-electronics, it can be used as light emitting diode in the blue to ultraviolet spectral region due to its band gap (3.7 eV) at room temperature. It is Known that the electrical conductivity of ZnS films is too low to act as a substrate for transistors, however it can be used as light source display screens and buffer layer films for $Cu(In,Ga)(S,Se)_2$ solar cells[3,4]. quite a lot of techniques such as sputtering[5], metal-organic vapour phase epitaxy [6], spray pyrolysis [7], and chemical bath deposition(CBD) [8] have been used to ZnS thin films.

Among them, the chemical bath deposition(CBD) is especially suitable, since it has been proved to be a simple and inexpensive method, particularly useful for perfect coating. Materials obtained by (CBD) find a wide range of applications. It can be used as photo detectors, optical mirrors, LCD, LED. It can be also used in decorative coatings etc.

Mn/Ni/F doping has been applied to some transparent semiconducting films such as CdO[9], CdS[10], ZnO[11], SnO_2[12]. It was reported by the references indicated above that the electro-optical properties of these films improved by fluorine-doping. The use of ZnS thin films is still partial to UV light due to its huge band gap, 3.6 eV [13]. Therefore, a lot of studies have been carried out to enlarge a visible –light active ZnS thin films through the doping of metal ions. Doping of ZnS thin films by the control metal ions Mn^{2+}[14,15], Cu^{2+} [16,17] and Ni^{2+} [18], has conventional considerable attention in applications in electroluminesce nce devices, phosphors,light emitting displays and optical sensors. The present resea rch work deals with the fabrication and characterization of ZnS thin films doped with Cu by chemical bath deposition(CBD) technique. The experimental optical, structural and morphological properties are discussed in detail.

EXPERIMENTAL TECHNIQUES

SUBSTRATE

The sueface to which the thin film is deposited in termed is substrate. The Surface of the substrate should be flat and smooth to form films .It serves as a mechanical support for the thin film and in electronic application it also serves as an insulator. The need for long term stability makes it imperative that no chemical reaction occur which would change the properties of the films .It should have an appropriate heat conductivity to ensure constant temperature of the surface operation of electronic devices

SUBSTRTE MATERIAL:

A number of materials like glasses ,ceramics and quartz are available for use as thin substrate .The nature and surface finish of the substrate materials said about has the maximum surface smoothness and is also optically plane .It is easily and cheaply available .For the present work , the substrate used is "GLASS"

5.1 SUBSTRTE CLEANING:

The substrate is first thoroughly cleaned to remove contaminants The cleaning process adopted depends on the selection of the substrate This information gives the influence of the substrate cleaning on the adherence , temperature , stability , resistance to radiation and for possible defects . The process of substrate cleaning involves the removal of contaminants such as link resides, finger prints, oil and airborne particulate material without damaging the substrate.

First of all the glass substrate is cleaning with soap solution then rinsed with distilled water. Again the substrates are cleaning with water and acetone and rinsed with distilled water and allowed to dry. Cleaning with acetone removes unwanted fatty material deposited on the substrate before coating. After cleaning the substrate it is stored in a dust free atmosphere until ready for use . Hence cleaning is essential for the preparation of films with reproducible properties .

METHODS OF DEPOSITION:

1) Ordinary dipping method (or) solution growth method
2) Controlled dipping method

SOLUTION GROWTH METHOD:

The solution growth of deposition of this polymer films involves simmersion of a substrate into polymer solution of a suitable concentration . Increasing the number of dipping increase the thickness of the film. One side film must be wiped by acetone. This is done to avoid the variation in optical parameter of the film.

CONTROLLED DIPPING METHOD:

In this process of deposition the method of dipping is controlled by stepper motor interfaced to microprocessor. The height of the coating depends on the pulley size used and the control of dipping depends on the speed of motor.

COATING MATERIALS:

Film: the layer of the materials on the substrate is known as film. In order to prepare the film, the sample materials preferred for the present are

- $ZnSO_4$
- KOH
- NH_4NO_3
- $CS(NH_2)$
- $CuCL_2$

SAMPLE PREPARATION:

PREPARATION OF $ZnSO_4$, KOH, NH4NO3, CS(NH2) AND CuCL2:

The cadmium chloride, thiourea does not go into solution immediately. The globules of $ZnSO_4$ and $CS(NH_2)$first absorb water, swell and get distorted in shape. So we need temperature and constant stirring to prepare this solution. For that purpose, we make use of magnetic stirrer, the beaker containing water and ZnSO4, KOH, $NH4NO_3$,$CS(NH_2)$ and $CuCL_2$ are placed over the magnetic stirrer. A magnetic pellet is dropped into the beaker and the temperature is set to 75̊.

The filed required to rotate the pellet is supplied by the magnetic stirrer. Now switch on the magnetic stirrer. After different times will go into the solution. Using this solution $ZnSO_4$,KOH,NH_3NO_4,$CS(NH_2)$ and $ZnCL_2$ dropped film is prepared.

5.6 UITRA VIOLET:(UV)

UV spectroscopy is type of absorption spectroscopy in which of ultra-violet (200-400nm) is absorbed by the molecule. Absorption of the ultra-violet radiations rests in the excitation of the electrons from the ground state to higher thvioletradi absorb equal to the energy difference between the ground stand higher energy state (delta E⁼ hf). commonly, the most favored transition is from the highest occupied molecular orbital (HOMO) to lowest unoccupied molecular orbital. (LUMO).For most of the molecules, the lowest energy occupied molecular orbital are s orbital's, which correspond to sigma bonds. The p orbital is at somewhat higher energy levels, the orbital (nonbonding orbital) with unshared paired of electrons lie at higher energy levels. The unoccupied or anti bonding orbital's (pie and sigma) are the highest energy occupied orbital's is the compounds.

The ZnS(CU) thin film is deposited on the glass substrate using chemical both deposition method at 80^0c in three hours. The various characterization techniques searches UV and XRD

RESULT AND DISCUSSION

Figure.1 shows that the plotting of the transmittance against the various wavelength in the range between 300nm to 800nm. The transmittance lies under 73% shown in figure.1 for the different wavelength.

The optical band gab energy is obtain from the plot of $(\alpha hv)^2$ against the photon energyas shown in figure.2 where α is absorption which is calculated from the wavelength data. The optical band gab energy of the Zns (cu) thin film is found to be 0.3 ev as shown in figure.3 by drawing a straight from the curve to the X-axis (photon energy). The thickness of the film found to be that 575nm. The plot of extinction αhv*αhv against the photon is as shown in figure.3. From the figure that there is gradually decrease in extinction co efficient with the increasing in the photon energy.

Thus the XRD analysis of ZnS (CU) film is shown in figure.4 The XRD analysis reveals that he ZnS (CU) thin film has hexagonal crystalline structure. This analysis also shows that the ZnS (CU) film on the substrate this amorphous are consists of small grains. It is found that the ZnS (CU) film deposited on the substrate has poor space crystallanity. However the ZnS (CU) film is microcrystalline and it consists of mixed phases of β (cubic) and v (hexagonal).

CONCLUSION

Synthesization of ZnS (CU) thin film has done by using glass substrate by chemical bath method [CBD]. It has cost consumption, easy construction and uniform coating materials. The temperature is kept at 80^0C thoughout the deposition process of 3 hours. The linear nature of absorption indicates that ZnS (CU) is a direct band gap material with the band gap energy equal to 0.3eV. The XRD image of the ZnS (CU) thin film gibes the information about the crystalline structure prepared thin film. It confirms that the film has hexagonal crystalline structure. It also shows that the film is a amorphous. This ZnS (CU) film can be also used as the UV reflectors and also the CDS ZN thin film has been used as various techniques such as highly reflecting coating mirrors. It can be used as photo detectors, optical mirrors, LCD, LED. It can be also used in decorative coatings.

List of Figures:

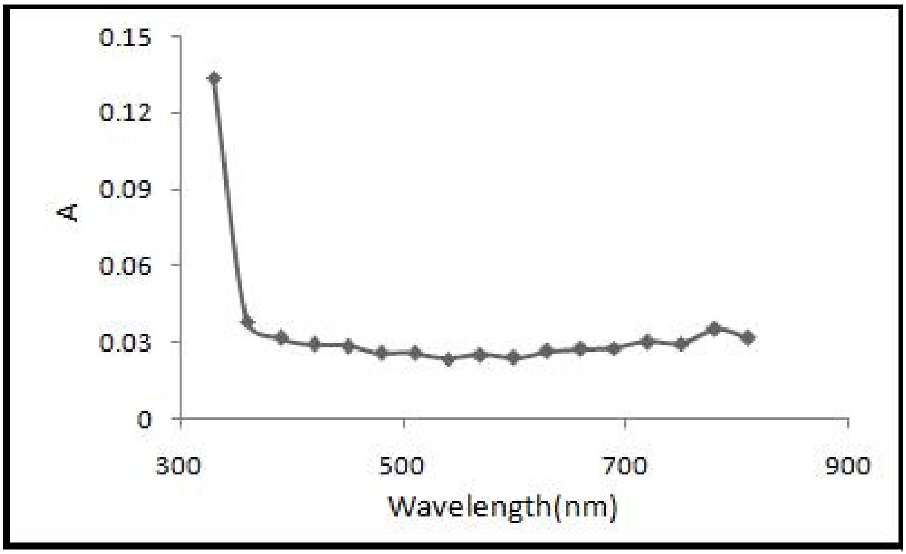

Fig. 1 Wavelength vs Absorbtion

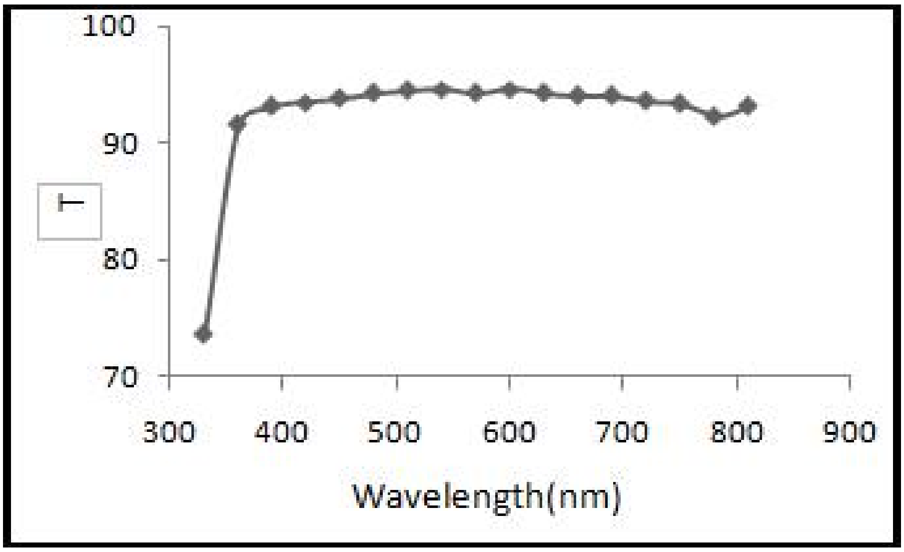

Fig. 2 Wavelength vs Transmittance

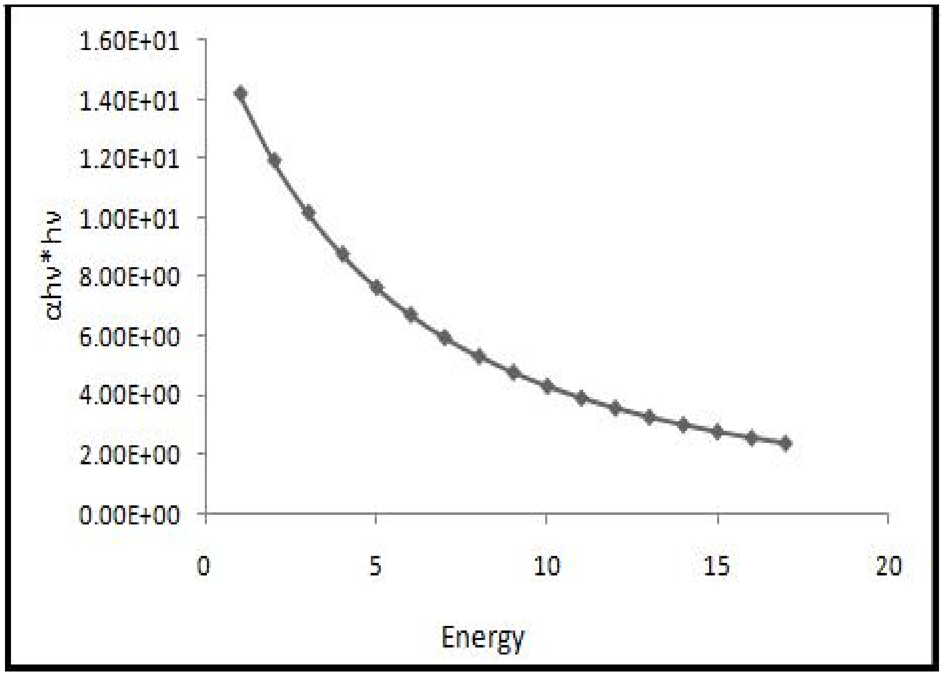

Fig. 3 Energy VS αhv*αhv

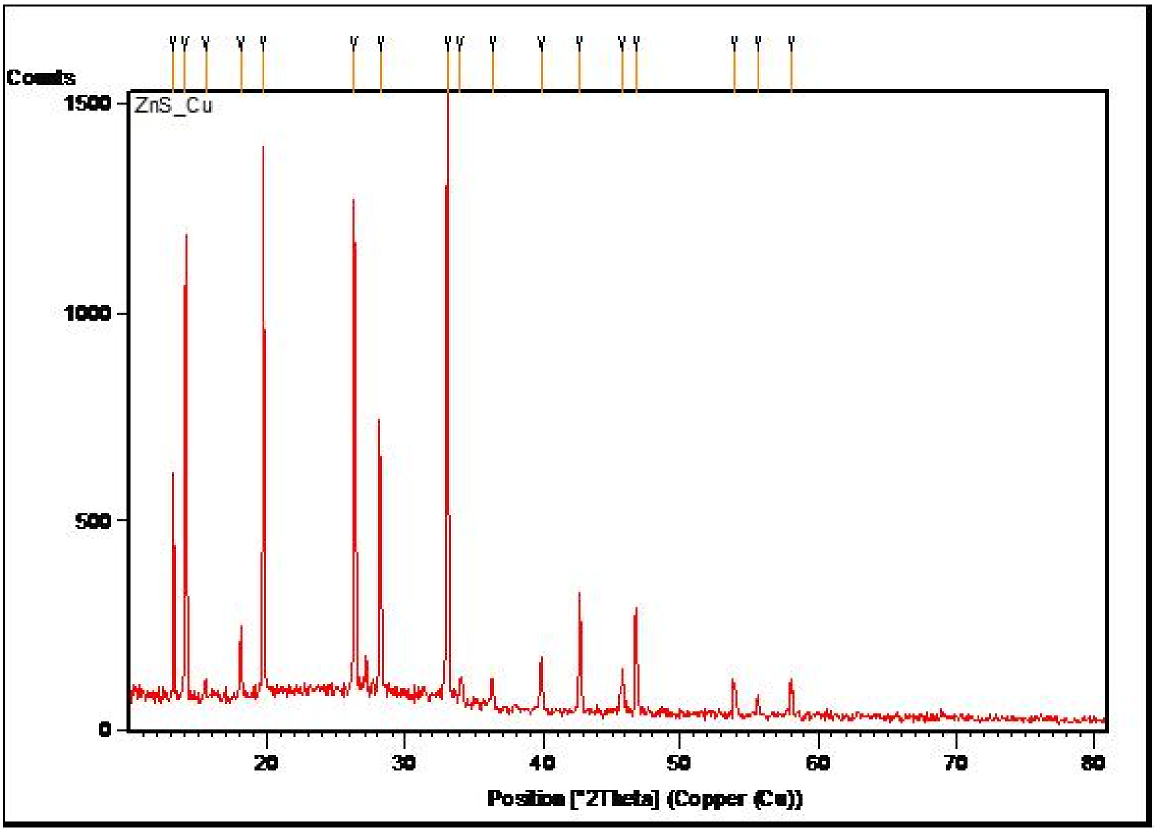

Fig. 4 XRD analysis

List of Table :

Table 1: Wavelength vs Absorbtion

WAVELENTH	ABSORBTION
330	0.134
360	0.0382
390	0.0315
420	0.0291
450	0.0284
480	0.0257
510	0.0255
540	0.0236
570	0.0249
600	0.024
630	0.0263
660	0.0271
690	0.0277
720	0.0301
750	0.0295
780	0.0352
810	0.0316

Table 2: Wavelength vs Transmittance

WAVELENTH	TRANSMITTANCE
330	73.6
360	91.6
390	93.1
420	93.5
450	93.8
480	94.3
510	94.5
540	94.6
570	94.3
600	94.6
630	94.3
660	94
690	94
720	93.6
750	93.4
780	92.3
810	93.1

Table 3: Energy VS αhν*αhν

ENERGY	αhν*αhν
3.766667	1.42E+01
3.452778	1.19E+01
3.187179	1.02E+01
2.959524	8.76E+00
2.762222	7.63E+00
2.589583	6.71E+00
2.437255	5.94E+00
2.301852	5.30E+00
2.180702	4.76E+00
2.071667	4.29E+00
1.973016	3.89E+00
1.883333	3.55E+00
1.801449	3.25E+00
1.726389	2.98E+00
1.657333	2.75E+00
1.59359	2.54E+00
1.534568	2.35E+00

REFERENCES

1. Ogura .T, Mikami . A, Tanaka .K, Taniguchi.K, Yoshida . M, Nakajima.S Appl. Phys. Lett. 48 (1986) 1570.
2. Lewis JS, Davidson MR, Holloway PH, J Appl. Phys. 92 (2002) 6646.
3. Monroy E, Omnes F, Semicond. Sci. Technol. 18(2003) R33..
4. Rusu M, Eisele W, Wurz R, Emnaoui A, Chi M,Lux-Steiner, Neisen TP, Karg F, J. Phys. Chem. Solids. 64 (1974) 165.
5. Murray.H, Tosser.A, Thin Solid Films. 24 (1974)165.
6. Zhang.Z.Z, Shen D.Z, Zhang J.Y, Shan C.X, Lu.Y.U, Liu, Y.C, Li B.H, Zhao.D.X, Yao.B, Fan X.W, Thin Solid Films. 513 (2006) 114.
7. Bacaksiz.E, Dzhafarov. T.D, Novruzov.V.D, Ozturk.K,Tomakin.m, Kucukomeroglu,T, Altunbas.M, Yanmaz.E, Abay.B, Phys. Status Solidi. A.Appl.Res. 201 (2004) 2948.
8. Zhai.R, Wang.S, Xu.H, Wang.H, Yan.H, Mater.Lett. 59 (2005(12)) 1497..
9. Bhosale.C.H, Kambale.A., Kokate.A.V, Rajpure.K.Y, Mater. Sci. Eng.,B 122 (2005) 67.
10. Podesta.A, Armani.N, Salviati,G. Romeo.N, Bosio.A, Prato.M, Thin Solid Films 448 (2006) 511-512.
11. Rodriguez-Baez.J, Maldonada.A, Torres-Delgado.G, Castanedo-Perez.R, De la.M, Olvera.L, Mater. Lett. 60 (2006) 1594.
12. Aukkaravittayapun.S, Wongtida.N, Kaseewatin.T, Charochkul.S, Unnanon.K, Chindaudom.P, Thin Solid Films. 496 (2006) 117.
13. Cheng K.W, Huang C.M, G.T.Pan,Chen.P.C,Lee.T.C,Yang.T.C.K,Mater.Chem.Phys. 108(2008) 16 Erat.S, Metin.H, Ari.M, Mater.Chem.Phys. 111(2008) 114.
14. Khosravi.A.A, Kundu.M, Jatwa.L, Deshpande.S.K, Bhagawat.U.A, Sastry.M, Kulkarani.S.K, Appl. Phys. Lett. 67(1995) 2702. .
15. Lee.S,Song.D, Kim.D,Lee.J, Kim.S, Park.I.Y, Choi.Y.D, Mater. Lett. 58(2004) 342.
16. Yang.P, Lu.M, Xu.D,Yuan.D,Chang.J,Zhou.G,Pan.M, Appl. Phys. A 74 (2002) 257.