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COMPREHENSIVE STUDY OF (CD-AG)S SEMICONDUCTING THIN FILM

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ABSTRACT
In this study the semiconducting (Cd-Ag)S (cadmium based silver sulphide)thin film were grown on the glass substrate by means of chemical bath deposition method (CBD). Film is deposited at the 60^0 in bath containing aqueous solution of cadmium acetate, silver acetate, thiourea, TEA and ammonia. Cadmium acetate for Cd ion source, silver acetate for silver ion source, thiourea for sulphur ion source, TEA is the complexing agent and ammonia for pH. The structural parameters of these films were studied by XRD. Photocurrent, Dark current and photoconductivity rise and decay studies have been done. Optical studies show high absorbances and high refractive index in UV as well as visible region. Quite good photosensitivity is observed in (Cd-Ag)S thin film.

KEYWORDS: Chemical Bath Deposition, XRD, Photoconductivity, Thin Film & TEA

INTRODUCTION

Cadmium based silver sulphide thin film is very important semiconducting material which shows quite good results like optical, structural and photoconductivity properties in the field of thin film. Cadmium sulfide (CdS) is a II-VI group semiconductor with energy gap covering the visible spectral range, which is used in many applications such as visible light emitting diodes and lasers [A. Pan(2006), Y. Gu(2005)], photovoltaic and photoconductive devices [A. A. Alnajjar (2006)]. On the other hand Ag_2S is a semiconductor material belonging to I-VI group with suitable for UV region.

In the present study, considering the advantages laid down by ternary compounds, the chemical bath deposition technique is used for the deposition of (Cd-Ag)S thin film. The growth, structural, surface morphological, compositional, optical and electrical properties have been studied over entire range of composition. (Cd-Ag)S is one of the promising materials having large spectrum of applications in selective coatings for efficient photo thermal conversion to obtain absorbance in the UV-VIS region and reflectance in IR region. Cadmium based silver sulphide is a photosensitivity materials. Cadmium based Silver sulphide show quite good photoconductivity behavior. Photoconductivity (PC) studies of I-VI compounds are quite important due to their broad applications in Xerography, photovoltaic solar energy conversion and thin film transistor electronics. Chemical deposition has been found to be quite useful since it presents low cost technique. Chemical Bath Deposition technique has been widely used for many advantages. CBD method is simple, easy going, comfortable handing process. It requires low cast instruments, minimum material wastage; economical way of large area deposition. CBD process uses a controlled chemical reaction to achieve thin film deposition by precipitation.

EXPERIMENTAL DETAILS

In the present experimental work chemical bath deposition (CBD) method has been used to prepare the (Cd-Ag)S (cadmium based silver sulphide) film. The deposition of (Cd-Ag)S film was done in a chemical bath prepared in a 50 ml beaker by addition of solutions of 6.65 ml of 0.1 M cadmium acetate as a source of cadmium,0.35ml of 0.1M silver acetate as a source of silver, 25ml ammonia for pH alkaline medium, 7 ml of 0.1 M thiourea as source of sulphur and 2 ml tri-ethanolamine(TEA) used as a complexing agent. Solutions of thiourea, cadmium acetate and silver acetate were prepared from analytical grade chemicals. Film deposition was produced by precipitation followed by condensation on glass substrates. The films were prepared at a constant temperature of 60^oC in water bath for 1 hour. The photoconductivity excitation source was an incandescent bulb of 60 W. For PC studies co-planar electrodes

of colloidal silver (1.5 mm wide, 24 mm long, with a separation of 2 mm) were painted and dried on the surface of the films. The photocurrents were measured using a nanometer at an applied voltage. The film was preserved in desiccators. The resultant film were homogeneous, well adhered to the substrate.

RESULTs AND DISCUSSSION

Dark Current

Fig 1 shows the behavior of the dark current with applied voltage for (Cd-Ag)S thin film. A linear behavior is observed between the voltages to the dark current.

Photocurrent

Fig 2 represent the rise and decay curves for (Cd-Ag)S thin film prepared by the chemical bath deposition method in a constant temperature water bath. The bath was made constant at 60^0C. The film reported here are prepared at this temperature. The deposition time for the film was 1 hour. The rise and decay curve have been found to be similar as reported in thin film paper. It is characterized by fast rise in the beginning followed by saturation. The initial increase in the photocurrent upon illumination is due to generation of photo carries. The slowly increasing part is when recombination becomes dominant. Decay rates appeared to be slower in (Cd-Ag)S thin film. The decay of photo excited electron prolonged by thermal excitation from traps to the conduction band may be taken responsible for the slow decay of the photocurrent.

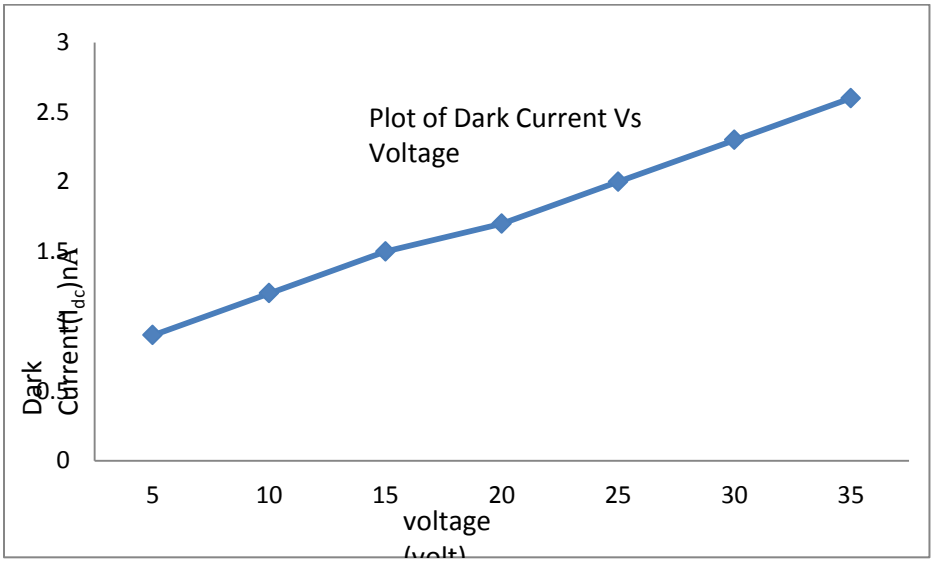

Fig 1-Plot of Dark Current Vs Voltage

Optical studies

Optical studies of the prepared (Cd-Ag)S thin film have been done by using Shimadzu UV/VIS 2700 spectrophotometer. Figure 3 shows absorbance curve of (Cd-Ag)S thin film prepared by CBD on glass substrate at optimize parameter. The absorbance found to be in the visible region, this shows that the (Cd-Ag)S material are important to use in photovoltaic technology.

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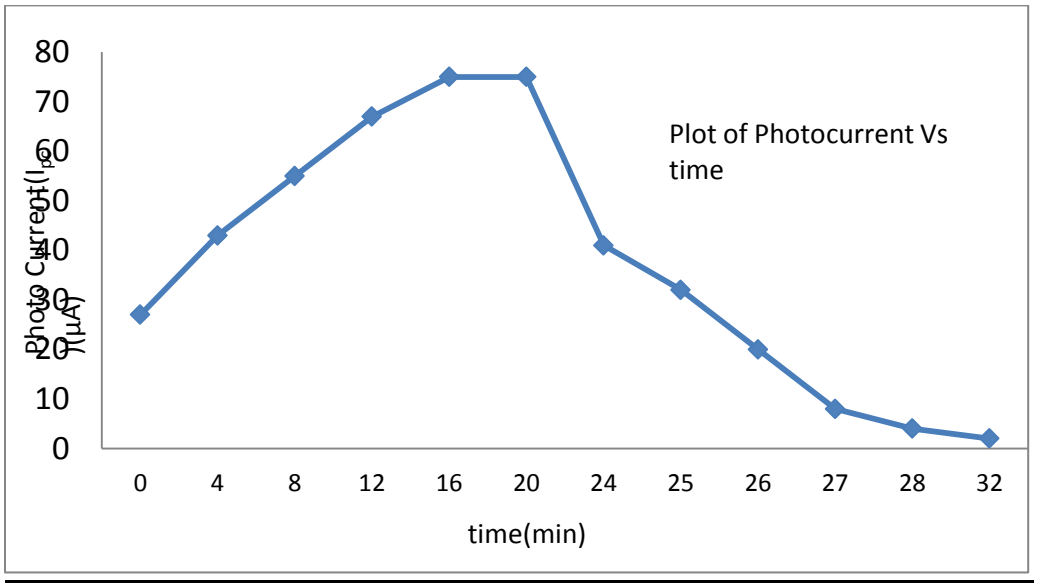
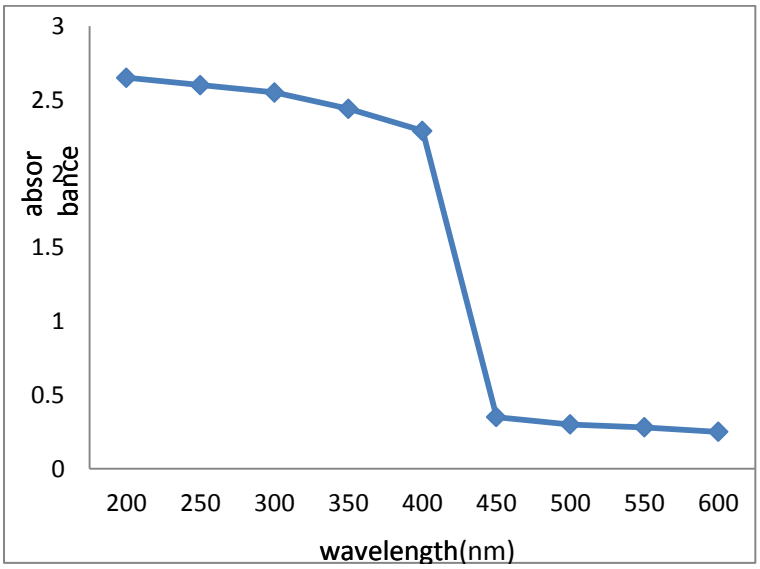


Fig 2-Plot of Photocurrent Vs time

Figure 4 represent the graph between refractive index against wavelength. Very high refractive index is found in (Cd-Ag)S thin film .High refractive index material can be used in photovoltaic technology so (Cd-Ag)S is the promising material for making photovoltaic device.



.**Fig 3- Plot of Absorbance with Wavelength**

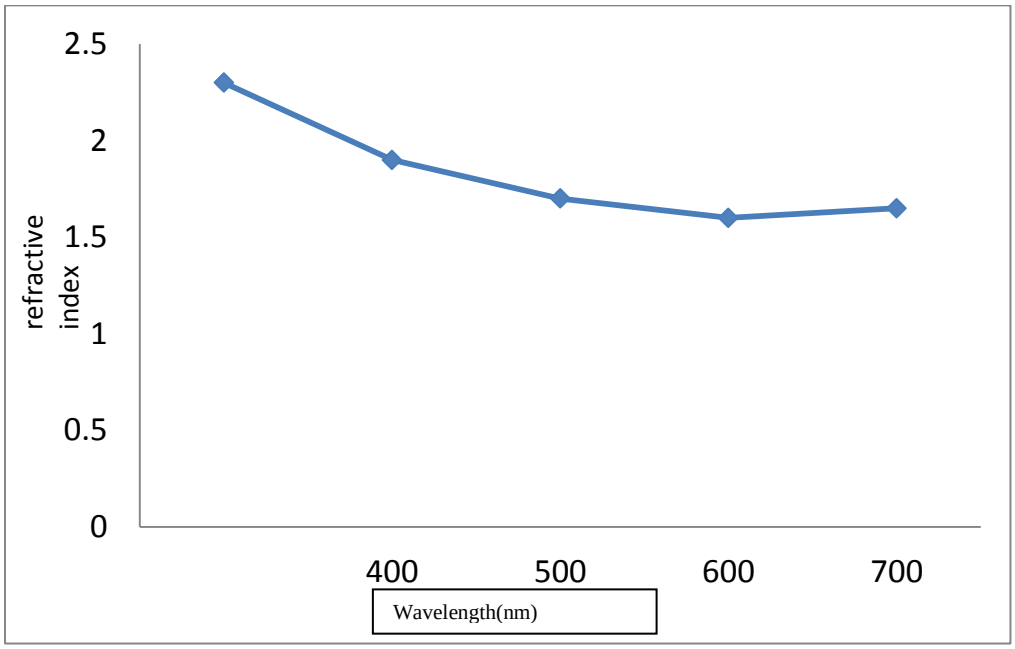


Fig.4-Plot of refractive index with wavelength

XRD Studies

Figure 5 shows the XRD pattern of (Cd-Ag)S thin film prepared by chemical bath deposition technique (CBD). The structural identification of (Cd-Ag)S thin film was carried out from the analysis of the X-ray diffraction pattern taken in the range of 2θ between 20^o and 80^o . The diffraction pattern of (Cd-Ag)S composite thin film shows polycrystalline nature with mixed hexagonal lattice due to CdS and Ag_2S The observed 2θ and d values are in good agreement with standard 2θ and d values due to (Cd-Ag)S. The (111),(220) and (311) orientation corresponds to hexagonal phase of (Cd-Ag)S.

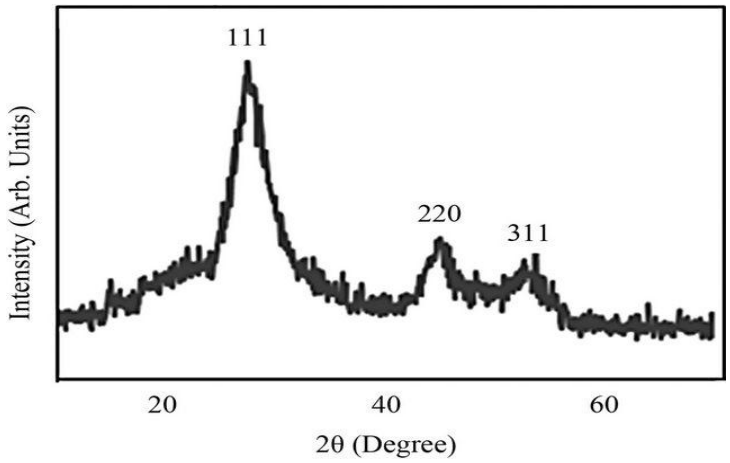


Fig. 5 XRD pattern of (Cd-Ag)S

CONCLUSION

Cadmium based silver sulphide thin film prepared by chemical bath deposition (CBD) technique shows good Optical, structural and Photoconductivity properties. In the present study cadmium based silver sulphide (Cd-Ag)S thin film have been successfully prepared by chemical bath deposition technique using cadmium acetate,silver acetate ,ammonia- thiourea system. The dark current studies shows linear behavior between applied voltage and current, rise and decay studies reflect information that the generation of photocurrent in the cadmium based silver sulphide thin film is very fast and decay rates appeared to be slower. The deposited thin film is found to be good photosensitive material. The absorbance found to be in the visible region. Very high refractive index is found in (Cd-Ag)S thin film .The structural analysis can be done by X-ray diffraction pattern of (Cd-Ag)S composite thin film shows polycrystalline nature with mixed hexagonal lattice due to CdS and Ag_2S.

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