International Journal of Multidisciplinary Research and Modern Education (IJMRME)
ISSN (Online): 2454 - 6119
(www.rdmodernresearch.org) Volume I, Issue I, 2015

STUDIES ON OPTICAL AND STRUCTURAL PROPERTIES OF Ag_2S FILMS PREPARED BY CHEMICAL BATH DEPOSITION METHOD

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Abstract:

Semiconductor nanocrystalline Ag_2S (silver sulphide) thin films were grown on the glass substrate by means of chemical bath deposition method (CBD). Films deposited at the room temperature in bath containing aqueous solution of silver acetate, thiourea, TEA, and ammonia, silver acetate for silver ion source, thiourea for sulphur ion source, TEA is the complexing agent and ammonia for pH. Optical studies show high absorbances, high refractive index, low transmittance and low reflectance in UV region. XRD studies reflect the existence of polycrystalline with monoclinic crystal & confirm the particle size reduction. The optical bad gap is 1.9eV.

Keywords: Chemical Bath Deposition, Ultra Violet, Thin Films & X-Ray Differection

Introduction:

Silver sulphide is an important chalcognide compound which has been studied for its world wide application in various fields of science and technology (1). Silver sulfide belongs to I-VI compound semiconductor materials with monoclinic crystal structure. Ag_2S thin films which are functional materials with applications in contemporary advanced technologies extended over photoconductive and photovoltaic cells, solar selective coatings, ion selective electrode and membrances to IR detectors, laser recording media etc (2).Silver sulphide appears to be a promising solar absorbing material as its band gap is between 1 to 2eV. Ag_2S possessed a unique combination of various properties like high dark ionic or electronic conductivity, photoconductivity and photographic sensitivity in a board range of wavelength as well as related photovoltaic and photochronic effects (3). The Chemical bath deposition method is relatively simple, inexpensive and highly reproducible technique. In the past decade silver sulphide thin film by CBD method have been successfully prepared on silica (4) glass (5) and polyamide surfaces (6).There are number of techniques like sol-gel electrostatic deposition, solvent growth d.c.magnetron, sputtering, molecular, beam epitaxy, PVP assisted solvo-thermal method, self-catalytic growth, hydrothermal synthesis, and chemical bath deposition etc. were used for the preparation of various semiconducting materials and nanocrystalline materials. By CBD method, the dimensions of the crystallites can be varied controlling deposition parameters like reaction time, temperature, pH and presence of impurities in the solution. CBD is a method of growing thin film of certain materials on a substrate immersed in an aqueous bath containing appropriate reagents at temperatures ranging from room temperature to 373K.Therefore it is planned to prepared films by CBD technique using appropriate fluxes and impurities and complexing agents to control reaction rate and hence to investigate the corresponding changes in structural and optical properties. The technology is based on

slow controlled precipitation of the desired compound from its ions in the reaction bath solution. A complexing agent acting as a catalyst is usually employed to control the reaction in a suitable medium as indicated by the pH to obtain crystal growth (7).

Experimental Details:

In the present work optically plane glass plate were used as the substrate to deposit Ag_2S thin film**.** Prior to the Experiment, substrate was put into the beaker containing HNO_3 acid and distilled water and then put into the beaker containing acetone. Then the substrate was dried in air. Film deposition was produced by precipitation followed by condensation on glass substrates. The deposition of silver sulphide films by using the CBD technique in a Silver acetate- ammonia- thiourea system. The chemicals used were 0.1 M of Silver acetate and thiourea, triethanolamine (TEA) used as complexing agent, aqueous ammonium was added into this solution to adjust the pH at the desired value. The films were prepared at room temperature for time durations (12 hour). Optimizing the complexing agent (TEA) and prepared silver sulphide thin films.

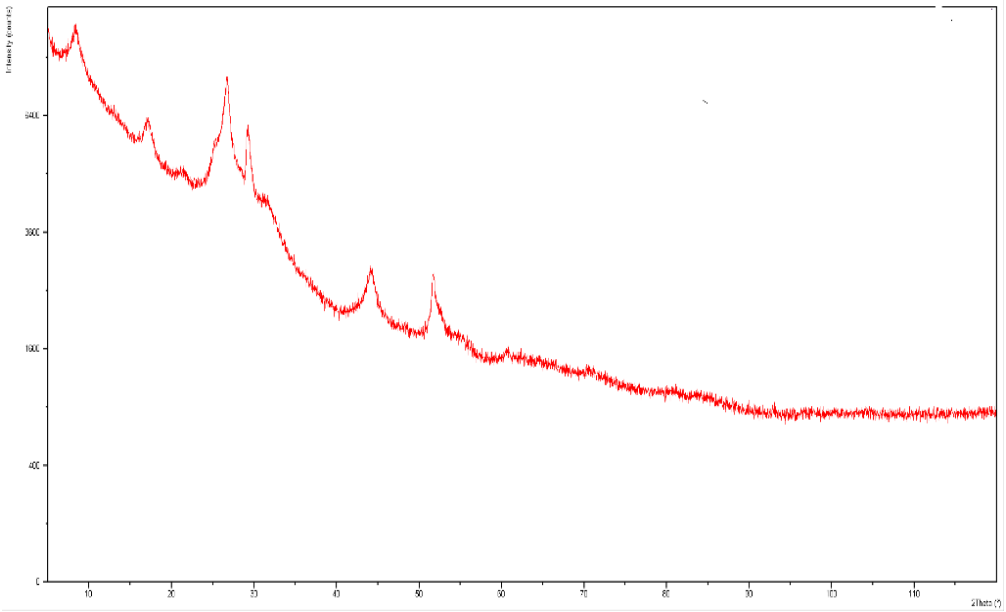
Optimizing Complexing Agent

Sample	Silver Acetate (ml)	Thioura (ml)	TEA (ml)
a	7.0	7.0	2.0
c	7.0	7.0	2.5
c	7.0	7.0	3.0
d	7.0	7.0	3.5

Result and Discussion:

Structural Studies:

The following fig. show the XRD pattern (sample a) of silver sulphide thin flim prepared by Chemical bath deposition technique. This curve is related to aqueous solution of thin films where bath containing comlexing agent TEA 2ml, silver acetate and thiourea is 7ml. It is observed that the XRD pattern shows major peaks at 25.12^0(111), 30.27^0(121), 34.67^0(112). XRD curve show the existence of polycrystalline with monoclinic crystal of silver sulphide thin films prepared by CBD.



Optical Properties:

Optical studies of the prepared silver sulphide thin films have been done by using Shimadzu UV/VIS 2700 spectophotometer.

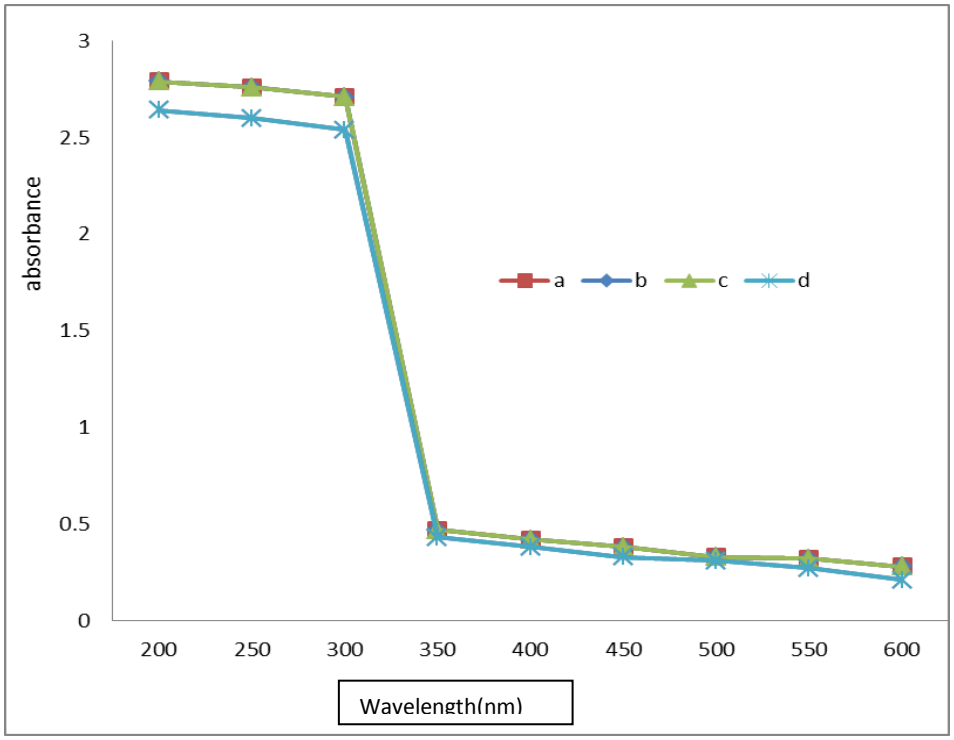


Figure 1: Curve between Absorbance and wavelength for silver sulphide thin films

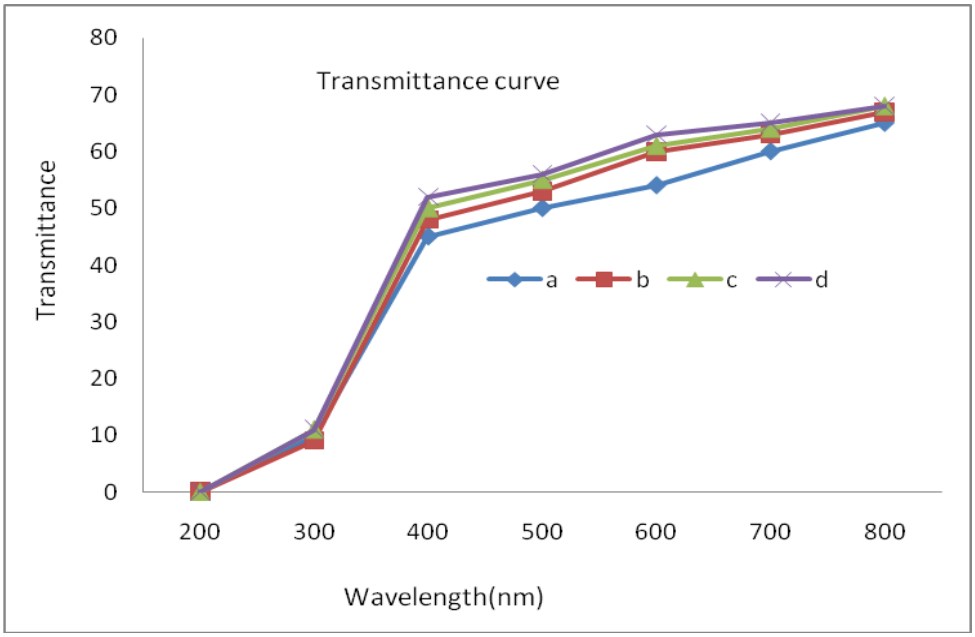


Figure 2: Curve between transmittance and wave length for silver sulphide thin films

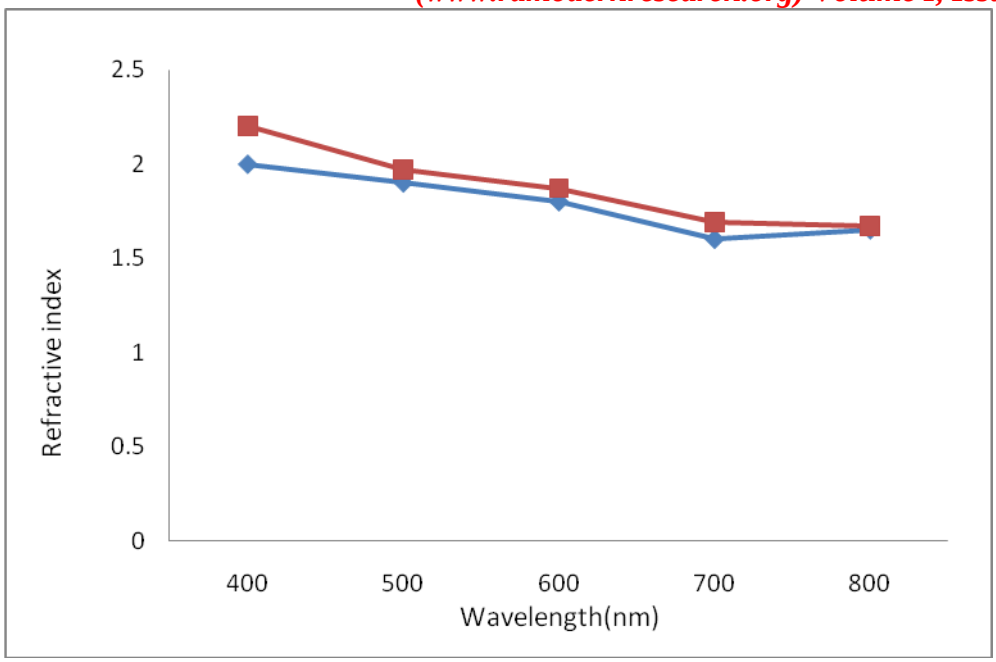


Figure 3: Curve between Refractive index and wavelength for silver sulphide thin films

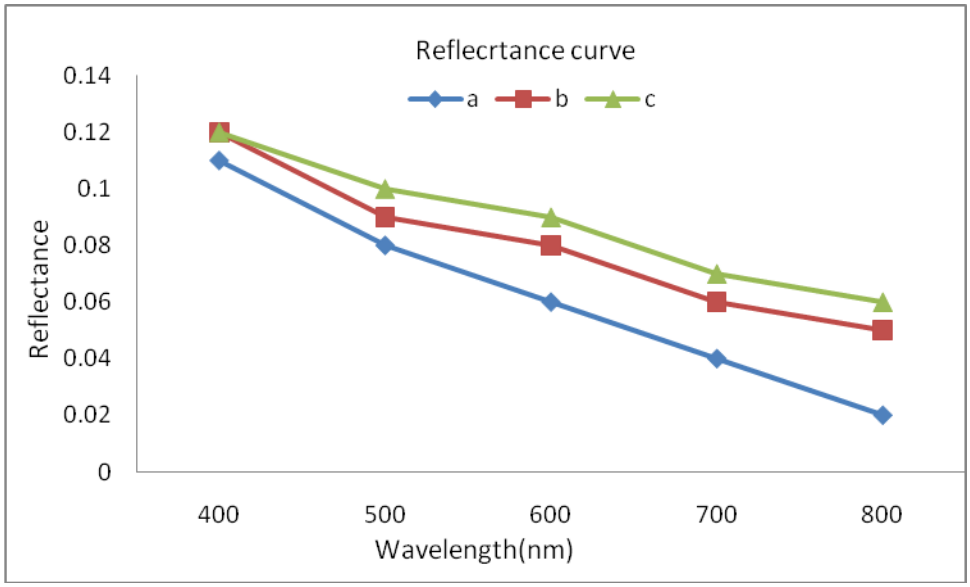


Figure 4: Curve between reflectance and wavelength for silver sulphide thin films

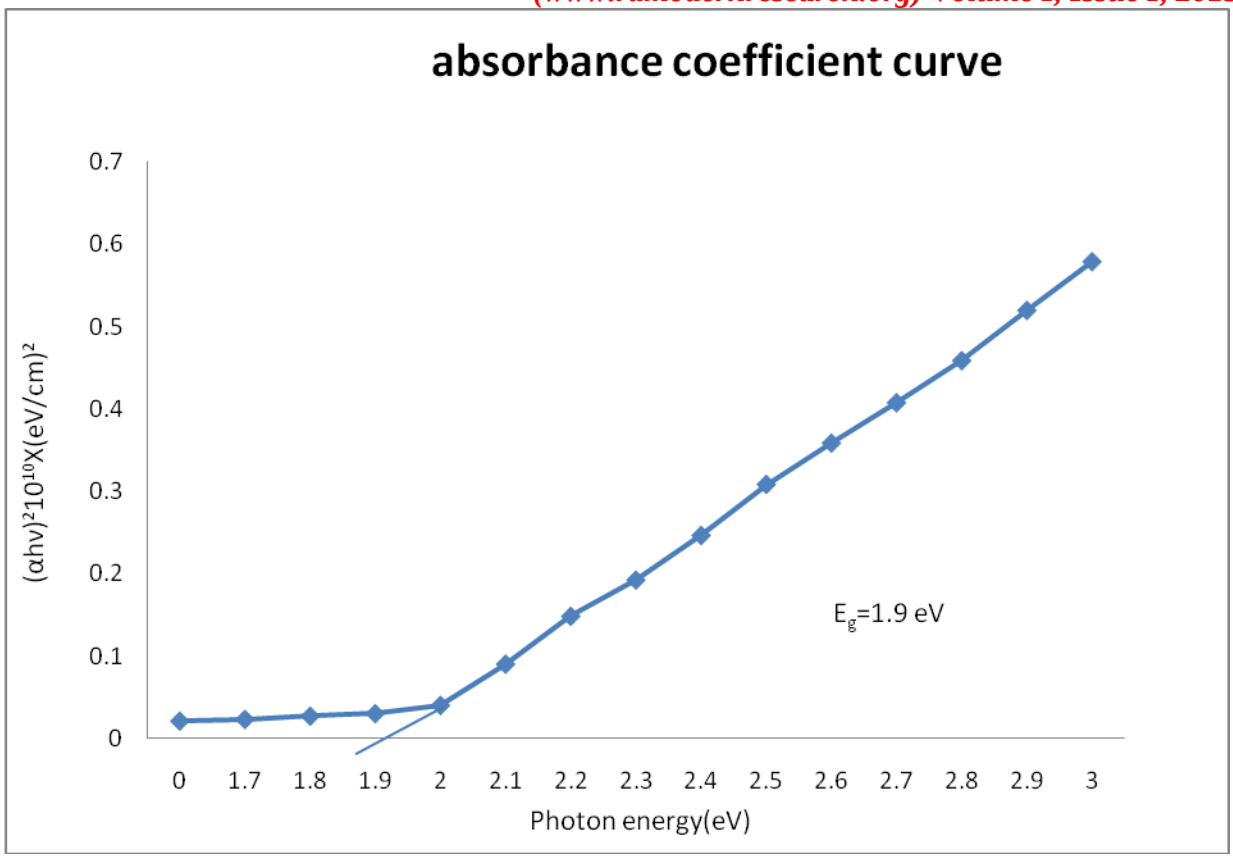


Figure 5: Curve between absorption coefficient squared and photon energy for silver sulphide thin films

Figure 1 shows a typical absorbance curve (Absorbance against wavelength) of silver sulphide (Ag_2S) thin films prepared by CBD on glass substrate at optimize parameter. All the films give almost the same absorbance curve in the UV region, this shows that the silver sulphide material are important to use in photovoltaic technology.

Referring to Fig 2 shows the graph of transmittance against wavelength for the different silver sulphide thin film. Very low transmittance found in the UV region and it is increases in the visible region .It indicate that the Ag_2S used for the collection device of solar energy.

Very high refractive index (>1.5) is found in silver sulphide thin films. Figure 3 shows a graph between refractive index against wavelength. High refractive index material can be used in photovoltaic technology so Ag_2S is the promising material for making photovoltaic device.

Figure 4 is the plot of reflectance against wavelength for silver sulphide thin films. Reflectance found to very low in UV, visible and infrared region, this result reflects information that the silver sulphide is anti reflection materials.

Figure 5 shows the graph between absorption coefficient and photon energy (ev) for silver sulphide thin films .The energy band gap found to be 1.9 eV. It very closed value which can be reported earlier in different paper, so silver sulphide thin film prepared by chemically bath deposition technique is good agreement to other method.

Conclusion:

In the present work silver sulphide thin films have been successfully prepared by chemical bath deposition technique using silver acetate ammonia- thiourea system. The optical studies of silver sulphide films deposited by CBD indicate that the deposited thin films is found to be good photovoltaic coating material and solar energy sensor device .A good quality thin films of Ag_2S were deposited and it shows high refractive index, low transmittance, high absorbance and low reflectance in UV region. The energy band gap is found to be 1.9ev.

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