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RESEARCH ARTICLE

OPTIMIZATION OF PREPARATIVE PARAMENTERS OF CHEMICAL BATH DEAPOSITED CDS AND FES THIN FILMS

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Abstract

The CdS and FeS thin films have been deposited on glass slides by simple chemical bath deposition technique. For good quality deposits the various preparative parameters such as deposition temperature, time, speed of substrate rotation and molar concentration has been optimized. Triethanolamine (TEA) was used as a complexing agent. The thickness of the film was optimized at 70 ^{O}C temperature and 1M concentration. The optimized time is 60 min. and the speed of the substrate rotation is kept at 60±2 rotation per minute.

Keywords: Chemical bath deposition, CdS thin films, FeS thin films, Molar concentration.

Introduction

Cadmium Sulphide is a II-VI group semiconductor. It has received considerable attention because of its potential use in the fabrication of solar cells (Minoru Isshiki and Jifeng Wang 2017; Waqar Mahmood 2018; Mycielski 1988). Several authors have deposited CdS and FeS thin films by various methods (Tripathi *et al.*, 2008; Chang 2003).

Iron and copper materials are very interesting because of their magnetic, semiconducting various optoelectronic properties. From the large family of iron sulfide phases, iron sulfide (FeS) is showing great interest because of its electronic, magnetic, and optical properties with applications that include solar cells. They are also found potential applications in the biomedical applications, including protein immobilization and separation, magnetic targeting and drug delivery, cancer hyperthermia, magnetic resonance imaging (MRI) and many more. Iron sulfides nanoparticles are considered to be advanced inorganic material with non-conventional applications, such as high-energy density batteries, precursors for the synthesis of superconductors and materials for photoelectrolysis. Therefore, the study of nonmaterial and thin film based on iron sulfide (FeS) with particle size and morphological changes is of great interest in the field of materials science. Various deposition and synthesis techniques have been experimented to deposit thin films of iron sulfide (FeS) including chemical vapor deposition, electro-

deposition, hydrothermal method, sputtering and chemical bath deposition. The chemical bath deposition is always found to be the simple, low temperature and cost effective method to deposit high quality thin films of FeS (Abey M Abraham *et al.*,2020; El-Hagary, M and S. Soltan 2012)..

In recent years, iron disulfide has attracted considerable attention as a candidate for alternative solar cell materials. The very high absorption coefficient and the composition of abundant, cheap and non-toxic elements make pyrite an interesting material for thin-film solar cells. Iron disulfide has a bandgap energy of E_g = 0.95 eV, (Lennie, 1995).

Experimental details

Thin film deposition

Preparation of the substrates

The amorphous glass micro slides supplied by 'Blue Star' (Mumbai) of dimensions 75 mm × 25 mm × 1.35 mm were cut into the desired size of 75 mm × 12.5 mm × 1.35 mm. These glass plates were used for the deposition and further studies.

Substrate cleaning

Substrate cleaning plays important role in thin film deposition. A clean and contaminant free substrate is needed for quality deposits. It affects the adherence, smoothness and uniformity of the film. The usual contaminants are lint residues, finger prints, oil and air borne materials. The following procedure has been adopted to clean the glass slides in the present study:

1. The glass slides were washed with detergent and distilled water;
2. Then they were boiled in concentrated chromic acid (2 M) for 30 min.;
3. These boiled substrates were cleaned with double distilled water;
4. Then, these substrates were ultrasonically cleaned for 15 min,

Finally, the substrates were dried, degreased in AR grade acetone and were used for deposition.

Preparation of solutions

i) Source material used for deposition

The basic source materials used for the deposition of CdS and FeS were as follows:

1. Cadmium Sulphate ($CdSO_4.H_2O$) (A. R. Grade), supplied by Boris Baker Ltd., Mumbai.
2. Iron Sulfate ($FeSO_4$.) (A. R. Grade), supplied by Boris Baker Ltd., Mumbai.
3. Thiourea ($CS(NH_2)_2$) (A. R. Grade), supplied by Boris Baker Ltd., Mumbai.
4. Triethanolamine (A. R. Grade), supplied by Boris Baker Ltd., Mumbai.
5. Sodium hydroxide (A. R. Grade), supplied by Boris Baker Ltd., Mumbai.
6. Liquor ammonia (25%) (A. R. Grade), supplied by Boris Baker Ltd., Mumbai.

Deposition of CdS, PbS and $Cd_{1-x}Pb_xS$ thin films

a) Deposition of CdS thin film

For the deposition of CdS thin films, the starting materials used were cadmium Sulphate and Thiourea. Aqueous solutions were prepared by dissolving these starting materials in double distilled water. Initially 10 ml cadmium solution was taken into 200 ml beaker and 3 ml Triethanolamine as a complexing agent was added in it. The total volume of the reaction mixture was then made 150 ml by adding double distilled water and the beaker was then kept in an oil bath whose temperature was controlled to 45 ^{0}C. Then well processed glass substrates were mounted vertically on a specially designed substrate holder and were rotated in reaction mixture with a constant speed of 35 rpm to achieve uniform churning. The deposition was carried out for 30 minutes and the samples were taken out from reaction mixture and detached from the substrate holder and then washed several times with double distilled water. The samples were preserved in dark desiccator [49]. Similarly, the temperature is varied to 50 ^{0}C, 55 ^{0}C, 60 ^{0}C, 65 ^{0}C, 70 ^{0}C and 75 ^{0}C. The substrate rotation was varied form 35 rpm to 70 rpm each time increasing by 5 rpm. The molarity of the solution is also varied from 0.1 M to 1.25 M and time from 30 min. to 70 min. The good quality thin films were obtained at optimized parameters shown in Table 1.

b) Deposition of FeS thin film

Similar procedure was used to deposit FeS thin films however instead of cadmium Sulphate, Iron Sulphate was used.

Table 1: Optimized preparative parameters for the deposition of CdS and FeS thin films.

Compound → / Parameters ↓	CdS	FeS
1. Substrates used	Amorphous glass	Amorphous glass
2. pH of the reaction solution	8 ± 0.1	8 ± 0.1
3. Molar concentration	1 M	1 M
4. Speed of the substrate rotation	60 ± 2 rpm	60 ± 2 rpm
5. Deposition time	60 min.	60 min.
6. Deposition temperature	70 ^{0}C	70 ^{0}C

Fig. shows the variation of film thickness with molar concentration, deposition time, speed of substrate rotation and temperature.

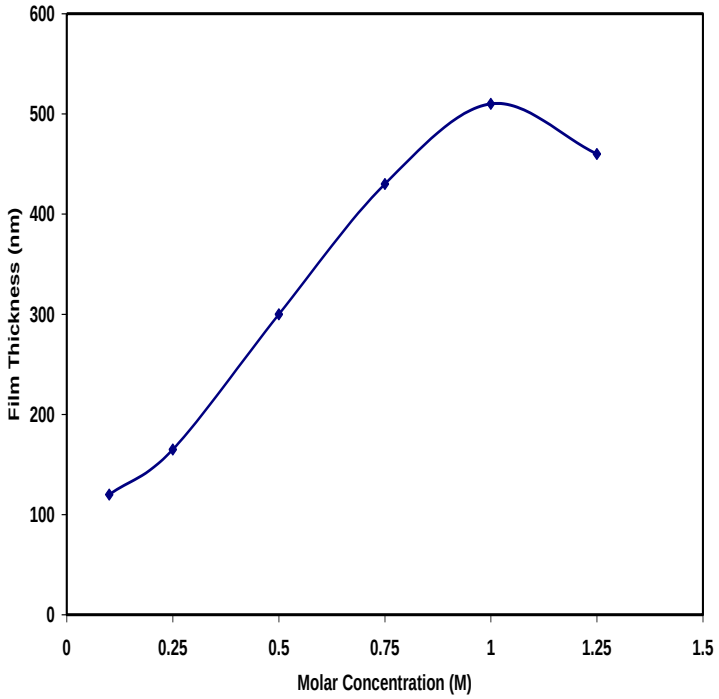

Fig. 1: Variation of film thickness with molar concentration

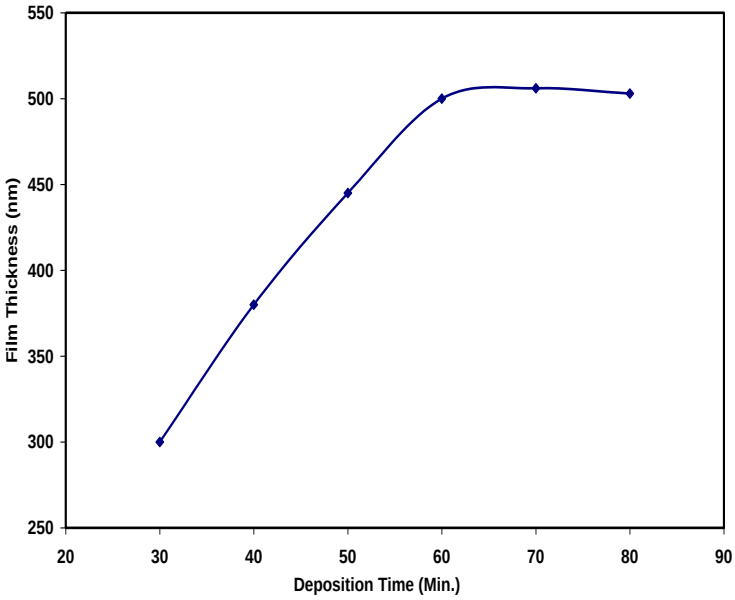

Fig. 2: Variation of film thickness with deposition time.

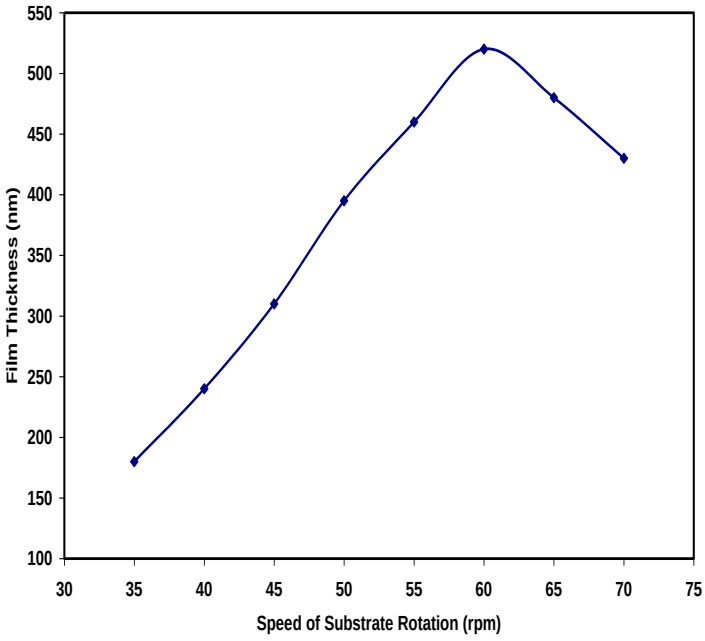

Fig. 3: Variation of film thickness with speed of substrate rotation.

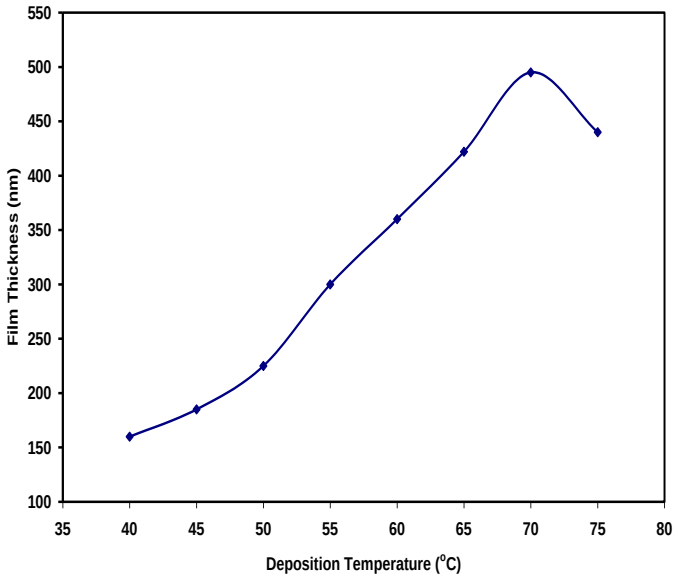

Fig. 4: Variation of film thickness with temperature.

Conclusion

The good quality thin films of CdS and FeS were deposited by simple and inexpensive Chemical Bath Deposition method. The optimized deposition temperature, molar concentration, speed of substrate rotation and deposition time is 70 ^{0}C, 1M, 60 rpm and 60 min. respectively.

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