



14. Synthesis and Characterization of Zinc Sulphide (ZnS) Thin Film by Pulsed Electrochemical Deposition of Two Electrode System

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Abstract

Zinc sulphide thin films have been deposited by electrochemical deposition using the two electrode system on stainless steel substrates from aqueous solution containing 0.1 N Zinc sulphate ($ZnSO_4 \cdot 7H_2O$) and 0.1 N sodium thiosulphate ($Na_2S_2O_3$). The 0.1 N Triethanolamine was used as a complex agent for complex form of ZnS materials. The Thickness of ZnS thin film was found to increases up to certain time after that it was found fall by co- deposition with deposition time. The depositing voltage 2000 mV corresponding current density 4.44 mA/cm^2 was fixed. The good quality adherent films of ZnS were obtained at 2000 mv in two electrode system. The thickness of film was measured by mass difference method with different deposition time was studied. The thickness of thin film was optimized $3.92 \mu\text{m}$ at 20 min. The thin film of ZnS characterized by UV-visible spectrophotometry. The Chemical Composition of ZnS analysed by EDAX.

Keywords: Electrochemical Deposition, Thickness of film, UV-Vis, EDAX

1. Introduction

For the last couple of decade's interest in the use of photo electrochemical solar cells lead to large amount of research in the search for thin film polycrystalline material with acceptable efficiency. Some time approaching that of single crystals. In recent years, thin films have attracted much interest because of their varied application such as semi conducting devices, photovoltaic, optoelectronic devices, radiation detectors, laser materials, thermoelectric devices, solar energy converters [1]. The Interest in the use of photo electrochemical (PEC) solar cells for low-cost energy conversion has lead to an extensive research in the field for novel and suitable thin film semiconductor materials. Recent investigation has shown that layered type semi

conducting cadmium chalcogenides group (CdSe, CdS, CdTe) which absorb visible and near [2]. IR light are particularly promising materials for photo electrochemical solar energy conversion. The ZnS thin film can be used as window layer for CdS/CdTe solar cell because band gap energy of window layer should be less [3]. The band gap energy of ZnS material is 3.94 eV [4]. The polycrystalline electrodes are economically desirable for solar cell applications. Hence this study has been directed towards obtaining ZnS thin film in polycrystalline nature. Many workers investigated the photo electrochemical property of ZnS single crystal. The structural, optical and Electrical characterization of electrodeposited ZnS thin films have been reported [5]. Many workers have been succeeded in depositing thin film of ZnS by electrochemical deposition technique by two electrode system. In this report an attempt is made to prepare ZnS films through electrochemical deposition technique by two electrode systems on stainless steel substrate which enables the film to be used for characterization studies like structural, surface composition, surface morphology and Electrical properties.

2. Experimental Work

Material and Method

The thin films of ZnS were deposited by electrochemical deposition technique by two electrode system on stainless steel substrate. The stainless steel plates were used as the cathode in two electrodes system with graphite as the counter electrode and stainless steel plate was the working electrode. The electrolyte was prepared by mixing solution of ZnSO_4 (0.1N), $\text{Na}_2\text{S}_2\text{O}_3$ (0.1N), the volume ratio of 1:1 respectively. The Triethanolamine of 0.1 N was used for as a complexing agent and well polycrystalline in nature [6]. The pH =4 of electrolyte solution was fixed by dilute NaOH. The double distilled water was used for preparation of aqueous solution of above precursor chemicals. Before deposition the substrate were thoroughly cleaned with double distilled water and acetone. The distance between the working electrode and counter electrode way kept constant as 1 cm during deposition of materials. From visual observation it was observed that a formation of uniform and well adherent Blackishfilm of ZnS take place [7]. The film was dried in IR lamp for 10 min. The detailed growth kinetics was studies by changing the deposition parameters such deposition time (min).

3. Result and Discussion

The concentrations of Zinc sulphate (ZnSO_4), Sodium thiosulphate ($\text{Na}_2\text{S}_2\text{O}_3$), were 0.1 N and 0.1 N Respectively. The films were grown at the optimized deposition potential of 2000

mV with respect to the current density 4.44 mA/cm^2 . When an electric field is applied between the working and counter electrode a fine ZnS thin film formation occurs on the surface of the substrate. The process of film formation is observed to be time dependent.

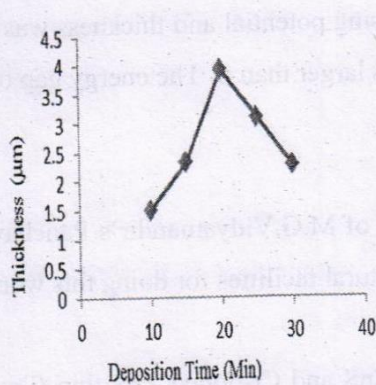


Fig 1: Variation of Deposition time with thickness of film

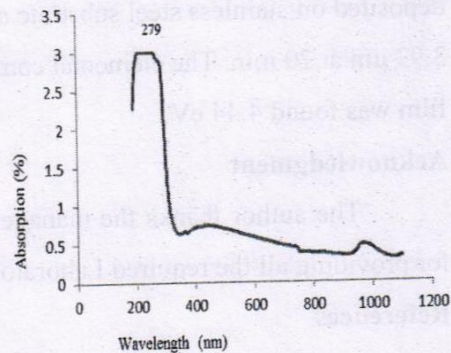
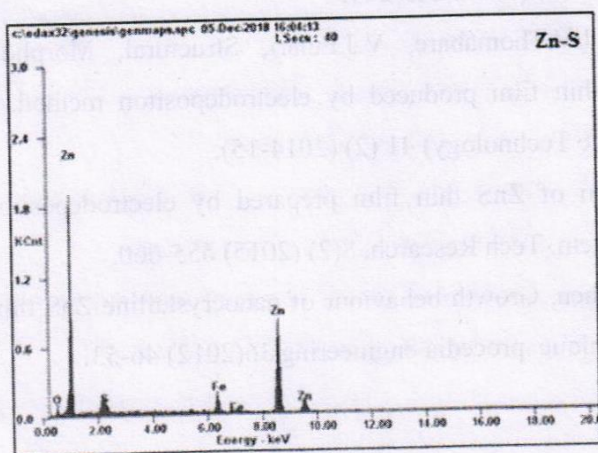


Fig 2: Absorbance spectra of ZnS thin film

In Fig 1 shows thickness of film increases with deposition time. The thicknesses of deposited materials were determined by mass difference method. The thickness of film was found $3.92 \mu\text{m}$ at 20 min as deposition time. The deposited film has been dried for further study. The current density was fixed at 4.44 mA/cm^2 during deposition. The film deposited at current density 4.44 mA/cm^2 was found to be uniform thick. And well adherent to substrate. Figure 2, shows the Energy band gap of ZnS thin film at pH=4. The films was analysed by UV-Visible spectrophotometry. The energy gap of ZnS thin film was found at 4.44 eV from **Figure 3**. The ZnS thin film characterized by Energy dispersive analysis by X-Ray. It confirmed ZnS thin film deposited on stainless steel substrate with Zn composition found high relative to S.



Element	Wt%	At%
OK	09.20	28.07
SK	04.09	06.23
Fe K	07.48	06.54
ZnK	79.22	59.16
Matrix	Correction	ZAF

Fig 3: EDAX of ZnS Thin Film and its Composition

Conclusion

The thin films of ZnS were deposited by electrochemical deposition technique by two electrode system on stainless steel substrate. The stoichiometric ZnS thin film uniformly deposited on stainless steel substrate at 2000 mv depositing potential and thickness was optimized 3.92 μm at 20 min. The elemental composition of Zn is larger than S. The energy gap of ZnS thin film was found 4.44 eV.

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