Synthesis And Structural Characterization Of Cadmium Sulphide (CdS) Thin Film by Electrochemical Deposition Of Two Electrode System.

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Abstract:

Cadmium sulphide thin films have been deposited by electrochemical deposition using the two electrode system on stainless steel substrates from aqueous solution containing 0.5 N cadmium sulphate ($CdSO_4 \cdot 2H_2O$) 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 CdS materials. The Thickness of CdS thin film was found to increases up to certain time after that it was found fall by co- deposition with deposition time. The deposing voltage corresponding current density was optimized by polarization curve method. The good quality adherent films of CdS were obtained at 1200 mv in two electrode system. The thickness of film was measured by mass difference method with different PH of electrolytic bath was studied. The chemical bonding of functional group of deposited material was studied by FT-IR spectral analysis. The weak intensities stretching band transmission was found at 2950 cm^{-1} of CdS material..The Structural characterization and surface morphology was studied by XRD, SEM respectively.

Keywords: Electrochemical Deposition, CdS, FT-IR, XRD, SEM.

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 [9]. 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 [9]. 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 chalcogenide group (CdSe, CdS, CdTe) which absorb visible and near [6].IR light are particularly promising materials for photo electrochemical solar energy conversion. The CdS thin film is used as window layer for CdS/CdTe solar cell because band gap energy of window layer should be less [2]. The band gap energy of CdS material is 2.42 ev [18].The polycrystalline electrodes are economically desirable for solar cell applications. Hence this study has been directed towards obtaining CdS thin film in polycrystalline nature. Many workers investigated the photo electrochemical property of CdS single crystal. The structural, optical and Electrical characterization of electrodeposited CdS thin films have been reported [7]. Many workers have been succeeded in depositing thin film of CdS by electrochemical deposition technique by two electrode system. In this report an attempt is made to prepare CdS 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.

Material and Method:

The thin films of CdS 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 $CdSO_4$ (0.1M), $Na_2S_2O_3$ (0.1M), the ratio of 1:1 respectively. The Triethanolamine of 0.1 N was used for complex form of CdS materials and well polycrystalline in nature [7]. The pH of electrolyte solution was varied by dilute HCL.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. 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 reddish yellowish film of CdS take place. [8] The detailed growth kinetics was studies by changing the deposition parameters such as the pH of electrolytic bath and deposition time (min). The chemical bonding of functional groups were analysed by FT-IR technique. The Thin film of CdS was further characterized by XRD, SEM.

Result and Discussion:

The concentrations of cadmium sulphide (CdSO4), Sodium thiosulphate (Na2S2O3), were 0.5 N and 0.1 N Respectively. The films were grown at the optimized deposition potential of 1200 mV with respect to the current density 4 mA/ cm^2.is shown in graph 1.When an electric field is applied between the working and counter electrode a fine CdS thin film formation occurs on the surface of the substrate. The process of thin film is time dependent. From graph 2 the thickness of film increases with deposition time. The thickness of deposited materials were determined by mass difference method. The thickness of film was found 200 μm at 25 min as deposition time. The deposited film has been dried for further study. The current density varied from 2 to 4 mA/ cm^2 during deposition. The film deposited at current density 4 mA/cm^2 was found to be uniform thick. And well adherent to substrate. For other higher and lower values of current density thickness of film was less as compared to 4 mA/cm^2.The PH of electrolytic bath is varied from 2 to 5 by adding dropwise dil 0.1 N HCl with measured thickness of film was found 200 μm and PH=3 was optimized.

FT-IR Analysis:

The FT-IR spectrum is used to understand and analyze more elegantly the structure and molecular arrangements of thin films. Type of functional groups present in the substance is indicated by the absorption that occurs at various frequencies [13]. Figure 4, shows the FT-IR spectra of CdS thin films in the range of 400-4000 cm−1.The vibrational frequencies of functional group have been presented in Table I. The absorption band at 3700 and 3600 cm^{-1}indicate the presence of Symmetric stretching of H_2O molecule, Asymmetric stretching of H_2O molecule respectively. The band at 3390 $cm^{-1}$for strong absorption shows S-O bond stretching of sodium thiosulphate molecule. CdS film showed weak intensities stretching band transmission at 2950 cm^{-1} . At 1550 cm^{-1} shows the presence of N-O strong stretching. Then S=O strong stretching at 1380 cm^{-1}. The absorption peaks were obtained at1134, 1080, 1024 cm^{-1} shows sulphate ion stretching and 813,767,588 cm^{-1} shows presence of, N-H, and C-H bending respectively.

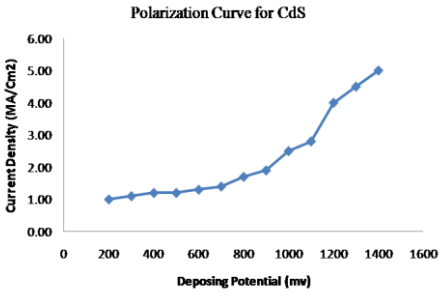

fig 1: deposing potential vs current density

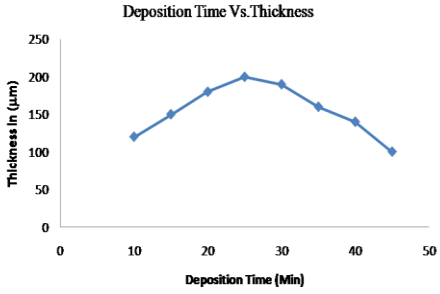

fig 2: deposition time vs thickness of film

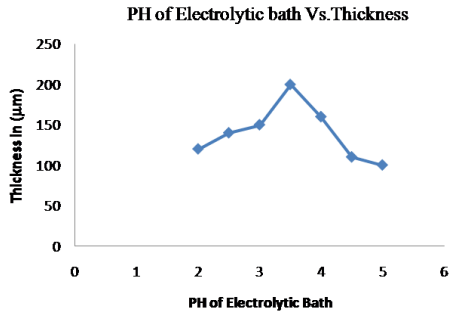

fig 3: ph of electrolytic bath vs thickness of film

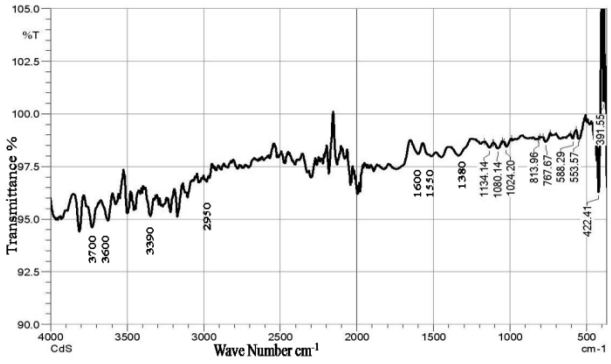

fig 4: FT-IR spectra of cds thin film

Table1: frequencies of the fundamental stretching and vibration of cds thin film

Frequency in Wave number cm^{-1}	**Assignment of Vibrations**
3700	Symmetric stretching of H_2O molecule
3600	Asymmetric stretching of H_2O molecule
3390	Sodium thiosulphate molecule.
2950	vibration of CdS
1600	Symmetric bending of H_2O molecule
1550	N-O strong Stretching
1380	S=O strong stretching
1134,1080,1024	Sulphate ion stretching
813	N-H bending
767,588	C-H bending

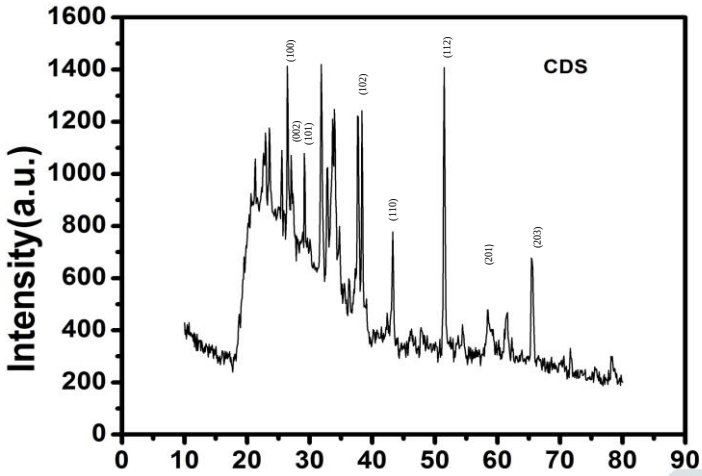

Fig5: XRD of CdS thin film

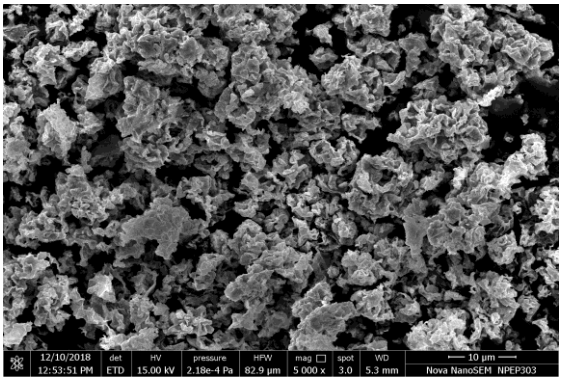

Fig6: SEM image of CdS thin film

According to XRD analysis the grain size was determined by Scherer relation $d=0.9\lambda/\beta\cos\theta$ The grain size was found 15.7 nm.and film was further characterized by SEM it indicate the CdS film distributed uniformly over stainl s steel plate with polycrystalline in nature.

Conclusion:

The Cadmium sulphide (CdS) film is successfully deposited over stainless steel substrate in aqueous bath by two electrode electrochemically deposited technique. The film was well deposited at 1200 mv polycrystalline nature with grain size 15.7 nm characterized by XRD analysis and surface of film was smooth it has been confirmed by SEM analysis.

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8. Cadmium sulphide (CdS) thin films deposited by chemical bath deposition (CBD) and dip coating techniques—a comparative study

Ankurkumar J Khimani[1], Sunil H Chaki[1], Tasmira J Malek[1], Jiten P Tailor[2], Sanjaysinh M Chauhan[1] and M P Deshpande[1] Published 14 March 2018 • © 2018 IOP Publishing Ltd
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Electrodeposition and optical characterisation of CdS thin films on ITO-coated glass
Author links open overlay pane lG.Sasikala[a]R.Dhanasekaran[a]C.Subramanian[a]

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