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Article

Characteristics of CdS Thin Film Fabrication by SILAR Method

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A B S T R A C T

This current article discuss about the fabrication of CdS using SILAR method which is cost effective. This method achieved elimation of high temperature annealing and usage of exposure of toxic elements which is followed by previous methods. Description of topography, compositional, optical and structural characteristics of a cost effective CdS thin film deposition using the SILAR method on glass substrate for window layer in solar cell application. The specimens were defined by the various instrumentation techniques such as X-Ray diffraction (XRD), UV-VIS-NIS spectrometry, Field Emission Scanning Electron Microscope (FESEM) attacted with Elemental Analysis (EDX). XRD results indicated prefect polycrystalline phase CdS. UV Spectrophotometer of CdS thin film was found Bandgap is 2.4 eV. At a glance the Morphology of the film by FESEM showed the deposited film is crack free and deposited uniformly.

Keywords: SILAR, CdS, Solar Cell, Band Gap Energy, Bottom-Up

Introduction

Due to their possible submissions in optoelectronic devices such as lasers, light emitting diodes and solar cells, the mixture and characterisation of cadmium sulphide thin films via numerous methods has attracted substantial attention.[1] Nanostructured semiconductor CdS exhibits actual dissimilar structural , electronic, optical, luminescent and photoconducting properties.

Of their substantial properties.[2-3] They therefore have potential applications prospects in solar cells, photodetectors, LASERs, LEDs, high-density magnetic information storage and many others in the semiconductor industries.[4] Cadmium sulphide is a wide band gap (2.42 eV) and a direct room temperature transition semiconductor.[5,6] Over the last decade , significant attempts have been made to synthesize CdS nanostructure thin films using many methods such as electrochemical synthesis[7,8], chemical bath deposition[5,9–15] solvothermal path[16], thermal evaporation[17], chemical vapor deposition,[18] vapor-liquid-solid development,[19] pulse laser deposition,[20] spray pyrolysis,[21] etc. In Chemical bath deposition (CBD) method, thin film deposition occurs due to substrate maintained in contact with dilute chemical baths containing cationic and anionic solutions. Film formation on the surface of the substrate occurs when the ion product (IP) exceeds the solubility product (SP). However, this results in precipitate formation in the bulk of the solution that can not be eliminated. A comparatively less used and less studied chemical technique is the successive ion layer adsorption and reaction (SILAR) which involves the successive dipping of the pre-cleaned substrate into a separate cationic and anionic precursor. As a result, precipitate formation and material waste can be avoided in this technique. Therefore, SILAR is often referred to as the modified version of the chemical bath deposition (modified CBD). Compared to other methods, SILAR deposition has a number of advantages, such as easy control of

Growth parameters, simple and cheaper. SILAR also

provides film processing on some kind of substrate at low temperatures and in mild working conditions. Reports on CdS development SILAR thin film is scarce.[1,22,23] Although Garadkar et al.[1] Used thiourea as a precursor to anion; Sun et al.[22]and Ubale Sodium sulphite et al.[23] used as an anionic precursor Which inevitably brings in the possibility of incorporating. Highly mobile carbon or sodium ions in deposited films. In Both these works used cadmium acetate as cationic solution. In this interaction, we document SILAR 's preparation of CdS thin films using ammonium sulphide as anionic precursor which eliminates the risk of incorporating unanticipated species into the films. We reviewed the accurate morphological and structural characteristics of CdS thin films deposited from SILAR.

Experimentation

Cadmium sulfide (CdS) was fabricated using a method called SILAR. Throughout this process, respectively catalyst solutions of cationic (Cd^{2+}) and anionic (S^{2-}) are considered individually. sInitially, the glassubstrate was immersed into a 0.1 M cationic precursor of Cd(OAc)2 5H2O / MeOH solution at 25 ° C for 2 min, then soaked with methanol to eliminate extra ions, then dried at 60 ° C for 2 min in a dried in an oven. This same film was again immersed in a 0.1 M anionic precursor of Na_2S / MeOH solvent at 25 ° C for 2 min, then soaked with methanol to erase residual solvents and afterwards dried at 60 ° C for 2 minutes. For CdS QDs this is one SILAR cycle. The yellowish-orange FTO / CdS colour film was achieved by following six more SILAR CdS cycles over the FTO film.

Completed thin films were studied by X - ray Diffraction (XRD) utilizing Philips X'pert diffraction spectroscopy configuration at 40mA, 45KV using Ni filtered copper-Kα radiation at such a spectrum of 0.0080[Å]-2 ɵ and 40s counting time per angle abscissa in the spectrum of 10^0 to 89.9962^0C.

Ocean Optical UV-1800 spectroscopy was used to estimate the UV-Vis - NIR wavelengths. The specimens have been measured in the wavelength ranges with scaling factor of nano meter the optical absorption coefficient valve.

JEOL FESEM convened with EDX to analyze particle size and elemental composition. The specimen is appended to copper tape with 96 micro amps of emission current, accelerating 10KV voltage. Film work distance 4 mm.

Results with Discussions

XRD Analysization

Fig. 1 represents x-ray diffraction (XRD) structure of a CdS thin film. The substance had been inspected in the 20^0–80^0 range. The 2θ variation was used a step of 0.05^0 and a step with time of 1s. In Figure, frequency is obtained by plotting toward 2θ in arbitrary units. 1. From the graph it can be seen that peaks occur at 26.59^0, 43.89^0 and 52.13^0. The Sample diffractogram discloses that certain peaks are also in excellent accordance to data from the Cubic CdS structure of the Joint Committee on Powder Diffraction Standard (JCPDS).24 The correlating mirror planes are (1 1 1), (2 2 0) and (3 1 1).

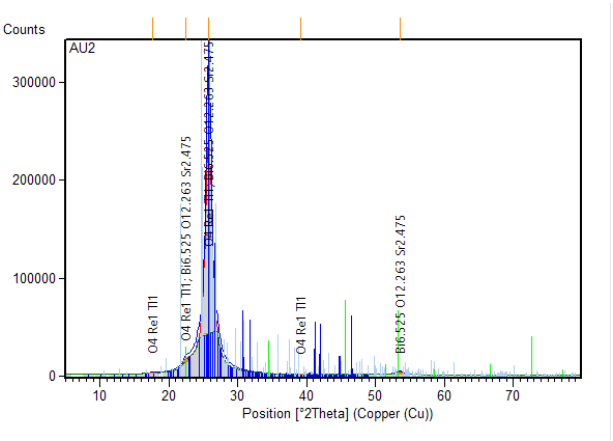

Figure 1.XRD plot for CdS film

Table 1.Crystalline size for CdS film

Peak position (θ)	Crystalline size (nm)	Lattice strain
26.59	17	0.0034

Bandgap Analysis

A perfect CdS film has a significant impact on the absorption of light which further implies on optical bandgap. Band Gap Energy (Eg) was extracted from the numerical data analysis acquired as from absorbance vs. wavelength range throughout the 400–700 near - infrared region for the CdS appropriate band gap[25] while using following relation:

$$(\alpha h\nu)^2 = A(h\nu - Eg) \quad (1)$$

Where v is the frequency, A is a function of the refractive index and the effective masses of the hole/electron, and h is a constant of Planck. Illustration. Fig 2 shows the plot of $(\alpha h\nu)^2$ as a function of electron density hv. Observation of both the accordance to start point, in which the valuation of α is zero, increases the ratio of Eg as 2.4 eV.

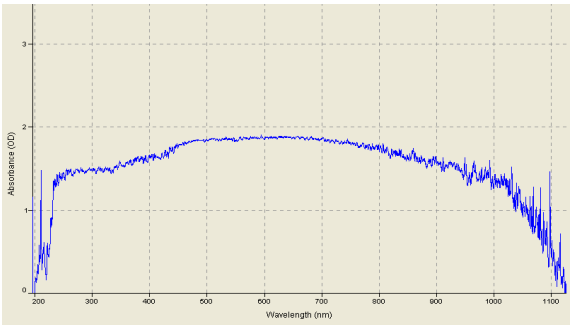

Figure 2.UV- Visible result for CdS deposited film

Table 2.CdS thin film bandgap value is 2.4 eV

Parameter	CZTS
Band gap (eV)	2.4
Wavelength (nm)	517

FESEM Analyis

FESEM analysis (Fig. 3) demonstrated polycristalline structure at reflection coefficient. Mostly from image, the accumulation of grains mostly on substrate surface is not seen. The total surface structure reflects grains placed on the surface of the substratum almost homogeneously with good adhesion without any kind of fractures. So we can infer that small amount of deposition will put CdS nanoparticles on the FTO. But all FTO NTs were coated by CdS nanoparticles and obstructed nanosized structures. This is undesirable for electrons and holes isolation, and therefore will prevent photocatalytic properties.

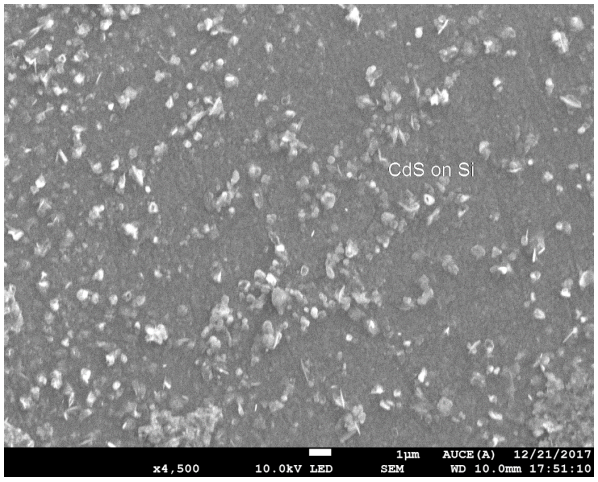

Figure 3.FESEM image of CdsS by SILAR technique

EDX Analysis

EDS analysis of CdS`s thin film fabricated by SILAR technique. From the data it was observed that they are very strong peak of cadmium and Sulfate of concern range of keV. The atomic percentage of each individual element in the CdS`s thin film is calculated by the peak strengths. The stoichiometry of CZTS thin film measured were 51.32% and 49.68% of Cadmium and Sulfate respectively which was approxiamately equal to 1:1. From the data it was observed that the stoichiometric ratio between S and Cd is 1:1, each. It implies mostly developed CdS component Cd and S. rich enough which aids in conversion efficiency

Conclusion

The major objective of the present paper would be to investigate the probability of production of CdS thin films utilizing SILAR method from nonsodium and noncarbon based anionic catalysts. Use of ammonium sulphide excludes the risk of inclusion of extremely mobile iodine or carbon electrons in the films. The method of SILAR is basic, analyze the data and provides an infinitely accessable option to industrial scale. Phase perfect CdS thin films may be effectively fabricated with SILAR using ammonium sulfide as a precursor to anion. Processes XRD show the cubic structure including its synthesized particles. Estimated particle size using an analysis of x-ray line extension was 17 nm. Transformation in energy band gap relative to high volume values show quantim containment.

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