Acta Ciencia Indica, Vol. XL P, No. 2, 87 (2014)

SPRAY PYROLYTICALLY PREPARATION OF $CD_XZN1\text{-}X_S$ ANNEALED THIN FILMS AND THEIR ELECTRICAL & OPTICAL PROPERTIES

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RECEIVED : 28 December, 2013

Present study aims at investigation of spray pyrolysis technique for deposition of $Cd_xZn_{1-x}S$ thin films with $0 \leq x \leq 1$ 0.9. The optical properties of the films were studied. In the wavelength range 380 to 1000 nm. The films have a polycrystalline with hexagonal structure from their X-ray diffractometer technique. The energy band gap varies from 2.5 eV to 3.5eV. As x increases from 0 to 1. The $Cd_xZn_{1-x}S$ ternary alloy compound have an electrical resistivity is a function of mole fraction x i.e. 10^4–10^{12} Ωcm. The annealing of the $Cd_xZn_{1-x}S$ at 240°C for 5 hours shows crystallanity improved and adherent, fluorescent in nature and is a promising semiconductor material for solar cell, electroluminescent and photoconductor devices. The variation of absorption coefficient % *R*, %*T* & Refractive index with coropossion *x* were studies in the present work.

KEYWORDS: CdZnS, spray pyrolysis, thin films, optical, XRD, electrical

INTRODUCTION

The ternary II III VI semiconductor (CdZnS, CdZnSe, CuInS and $CuInSe_2$) have been a great deal of attention due to their potential use in solar cell application having the cubic hexagonl structure and optical band gap 2.5 to 3.5 eV. The optical properties of CdS and ZnS thin films have been studied in the recent year [1, 2].

The optical properties are closely related to the composition of the films thickness, substrate temperature, spraying rate, and annealing of the films. Many authors prepared Cd_xZn_{1-x} Te, $CdInS_2$, $Bi_2Sb_2Se_3$. But very few articles are founds on CdZnS by CBD method. Hence aim of this work to study the optical and electrical properties of composition $Cd_xZn_{1-x}S$ with ($0 \leq x \leq 1$) in the form of thin films.

Different techniques of thin film deposition such as double. Source method, flash evaporation, chemical vapour techniques and spray pyrolysis method has been successfully used in the deposition of a number of chalcogenide semiconductor [3, 4, 5].

Thickness of the film is measured by using Michelson interferometer and weighing method. The effect of preparative parameter on optical and electrical properties of $Cd_xZn_{1-n}S$ thin films has also been studied.

EXPERIMENTAL

The polycrystalline $Cd_xZn_{1-x}S$ films were prepared by spray pyrolysis techniques. The contain amount of pure cadmium chloride ($CdCl_2$), zinc chloride ($ZnCl_2$) and thiourea ($NH_2CS\text{-}NH_2$) equimolar concentration (0.01M) was used. The system was generated employing the cadmium chloride. Zinc chloride and thourea as a starting material. The thiourea solution was taken 10 ml and taken constant throughout in a sprayer and was complex with appropriate quantity of cadmium chloride and zinc chloride ($0 \leq x \leq 1$), the pH of the complex was then made to 10.5 ± 2 by adding liquid ammonia so as to increse the adderence of the film.

These provide a soluble hydroxide phase of the metal to initiate the film growth. Ion-by-ion condensing was promoted by using a completing agent for metal ions so that the availability of the free metal ion is controlled trough the chemical equilibrium. And the solution was thoroughly sprayed by specially designed glass sprayed on a amorphous preheated cleaned glass substrate at 350°C for 15min. A spraying rate was kept 10 ml/min by controlling air pressure through the compressor. The sprayed deposited $Cd_xZn_{1-n}S$ film with different zinc and cadmium composition in thiourea are denoted by $Cd._0ZnS$, $Cd._2Zn._8S$, $Cd._4Zn._6S$, $Cd._6Zn._4S$, $Cd._8Zn._2S$, $Cd._1Zn._0S$.

The glass sprayer congaing solution was mechanically moved to and fro during spraying for uniformity of the film thickness and to avoid formation of droplets on the hot substrate. The optical absorption was studied (%T, %A) with ELICO.SL 159 UV-VIS spectrophotometer in the wavelength range 380-1000 nm. The electrical resistivity was measured by two probe method in the temperature range 300 ^{0}k to 500 ^{0}k. The structural characterisation was studied with X-ray diffraction technique using Phillips 60PA Cu-Kα radiation at 40 KV and 30 mA with wavelength 0.1542 nm was used.

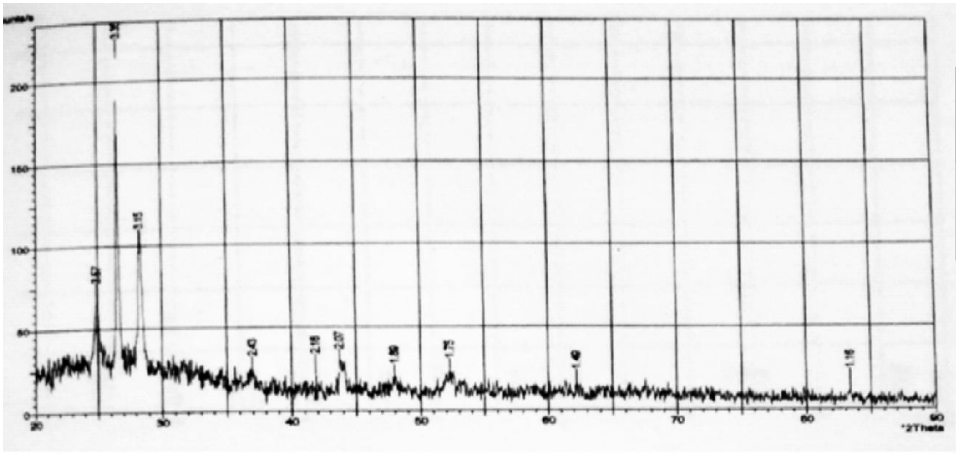

Fig.1 (a) XRD pattern of $CdxZn_{1-x}S$ thin films of thickness 0.532 µm

Result and disussion

The grown $Cd_xZn_{1-x}S$ films were yellow in orange with smoky appearances as x varies from 0 to 1. All the films were thin, tightly adherent, hard diffusely reflecting and relatively uniform. For the different films the optical transmission and absorption spectra were recorded at room temperature by ELICO-SL 159 UV-VIS spectrophotometer. The absorption

coefficient (α) was calculated as

$$\alpha = 1/t \text{ In } (1/\%T)$$

where t is the film thickness. T is transmission coefficient from Fig. 1 (a) the absorption coefficient (α) attained a minimum value at higher wavelength region and increases with decrease in wavelength and this shows the absorption edge of semiconductor and homogeneity of the semiconductor.

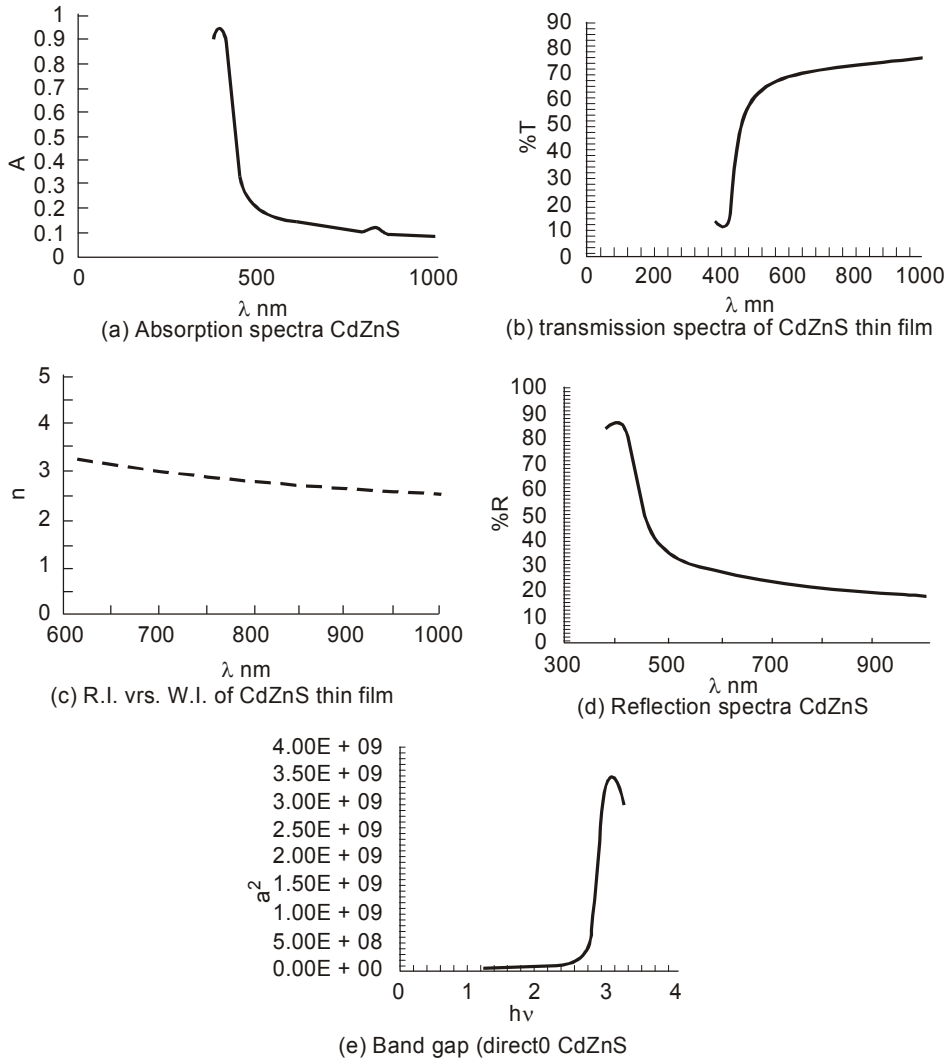

Fig. 1 (b), (c), (d) Optical properties of $CdxZn_{1-x}S$ thin film at room temp.

Fig. 1 (b) shows the plot of $(\alpha h\upsilon)^2$ verses $(h\upsilon)$.

This gives the direct band gap in the range 2.5eV to 3.7eV.

This value is comparable with the band gap reported by [6, 7, 8]. The refractive index (μ) with wavelength λ were calculated by using relation [9, 10].

$$\mu = 1 + (R/100)^{1/2}/1 - (R/100)^{1/2}$$

Fig. 1 (c) shows, μ verses λ shows that it is found to be constant for the wavelength 422 nm the *x*-ray diffraction pattern of $Cd_xZn_{1-x}S$ thin films of different composition having same thickness (321μm) the pattered are typical and crystalinity increases with annealing of the films. *X*-ray analysis is show in fig. 2 shows they are polycrystalline cubic-hexagonal. The position of the peaks corresponding to the angle 2θ = 25°, 26.5°, 27.5°, 37°, 44° etc indicates the structure of the film.

The electrical resistivity is depend on composition x was studied from 300°K to 500°K fig. 3(a). The dark resistivity of $Cd_xZn_{1-x}S$ as a function of mole faction x is shown in fig. 3 (b) the result of the earlier studied [11]. The electrical resistivity is of the order of 10^4 to 10^8 Ωcm [12].

Conclusions

The preparative parameters of the $Cd_xZn_{1-n}S$ thin film by spray pyrolysis have good adhesion and uniformly have been standardized air annealing increases crystalinity, conductivity, %T and reduces the resistively due to the grain growth by sharpening the XRD patterns. The direct energy band gap in the range 2.5eV to 3.7eV.

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