Characteristics the Structural, Morphological and optical properties of $Cd_{1-x}Sn_xS$ thin films

Nadia J.Ghdeeb
Department of Physics, College of science, University of Mustansiriya, Baghdad, Iraq.

Abstract

The $Cd_{1-x}Sn_xS$ thin films were deposited positively on the glass bases by pyrolysis method. Films have grown in the substrat temperature is 300 ° C. The thickness of the films (200±5)nm.

XRD files have shown that polycrystalline films the hexagonal structure grew preferentially along the axis (002). The Optical studies carry direct transfer allowed. Energy gap Vary from 2.35 to 2.4 eV.

Key words: $Cd_{1-x}Sn_xS$ films, structure, morphological, optical properties

1.Introduction

Thin-film studies are important topics of solid state physics. Thin-film technology has contributed significantly to the study of semiconductors And the determination of many physical and chemical properties to determine their use in different applications. The term thin membrane is called a layer or several layers of material atoms that do not exceed one micron.

The thin film is defined as a layer of layers of material atoms that is the thickness of the microns [1, 2]. There are several methods for preparing thin films. The choice of suitable preparation technique depends on several factors: raw material type, final film specification, type of base, application areas, sedimentation rate and production costs.

Cadmium sulphide (CdS) is a semi-conductive substance of the second-sixth group (II-VI) in the periodic table [3]. The crystal-like structure of this firm is the cube and hexagonal [4]. The unity of the cell of the concentric type (f.c.c.) and the current connecting the sulfur and cadmium ions is a covalent signal resulting from the interconnection of electrons between the cadmium atom and the sulfur [5]..

The CdS crystal has a yellow-orange color [6]. The type of coupling of CdS in nature is p-type and can be n-type depending on the preparation process [7] or by adding some impurities (Ag, In, Cl, Br).
A mono-sulphide tin is a chalcogenides composed of the reaction of an element. Transition elements with one of the elements of the sixth group in the periodic table [8]. It is a class vehicle in which the composite consists of layers in the form of racks, this property makes the compound useful in many experiments that require a semiconductor with a surface that is renewable and production crystalline structure For tin mono sulphide of the existing type, and mono-sulphide tin is a semiconductor of the positive type (p-type).
It is used as a window in the solar cells to have a high absorption factor in the visible spectrum and is used as thinners for reflection. Its few reflections in this region are used in the manufacture of hybrid cells with hybrid separators. [9] $Cd_{1-x}Sn_xS$ thin films were deposited by chemical spray pyrolysis technique at different composition of (x) .The effect of tin concentration on the structural , morphological and optical properties of these films was studied.

2. Materials and Method

$Cd_{1-x}Sn_xS$ thin films were prepared on glass Bases at 300°C by CSP technique using aqueous solutions. The spray solution contains of size (0.05M) ($CdCl_2.H_2O$), (NH_2CSNH_2) and 0.05M ($SnCl_2.2H_2O$) solutions. The shape of Cd1-xSnxS movies changed from pure CdS (x= 0 ,0.1 ,0.2 ,0.3 ,0.4).
The spraying process was carried out by selecting the suitable conditions and stabilizing them by heating the glass bases to be deposited at 300Co and the flow rate of the water solution (2ml.min-1). The space among the Nozzle and the electric heater was fixed at 30cm.
The thickness of the thin films can be measured in several ways, including the electrical method, the optical method, the mechanical method, the scanning electron microscopy technique (SEM) and the approximate weight method that were adopted in this research. Where the weight of the base to be deposited before and after deposition is measured using the sensitive balance and knowledge of the density of the material (thin membrane) as well as the area of the film can be calculated thickness of the membrane using the relationship [10].

$M = (W_t / M_{wt}). (1000 / V)$…………… (1)
M: concentration of molarities.

W_t: The mass essential to dissolve

V_{ml}: Volume of distilled water,(100 ml).

M_{wt}: Molecular weight of matterWhere.

3. Results and Discussion

The importance of this measurement is to know the crystalline structure of the material, the phases of the material and the nature of the order of the atoms and their direction.

Through x-ray diffraction patterns and to a different concentration of

Sn are given in Fig (1). The Presence of several diffraction peaks, and sulphide phases in the deflection patterns shows the polycrystalline nature of the $Cd_{1-x}Sn_xS$ sample. It is seen that Crystallization of the CdS movies is better than that of the other movies .It should be noted that the XRD patterns show clear dependency on Tin concentration. The CdS film has been crystallized in a hexagonal (JCPDS Card no:96-101-1055) with the better orientation of(002) as shown in Fig .1. The intensity of the peak consistent to the CdS phase decreases as SnS concentration increases as shown in Fig .1. The SnS phase becomes principal with lower Cd content . The grain size (D_{hkl}) of Cd_{1-x} Sn_xS thin films where x equal (0 , 0.1 , 0.2,0.3 & 0.4) are calculated for the favorite planes [hkl] by the scherrer 's equation [11] The Strucural Parameters Of $Cd_{1-x}Sn_xS$ thin film in table (1)

$$D_{hkl}=K\lambda/\beta_{2\Theta}\cos\theta \quad ....(2)$$

With k=0.94 ,where θ is the Bragg's angle λ is the wavelength X-ray used , $\beta_{2\Theta}$ is the width of the peak at the half of the maximum peak intensity . the calculation of the dislocation density rate from equation (3), and The strain developed can calculated from the equation(4) [12] Variation Of the FWHM ,D , ε and δ of $Cd_{1-x}Sn_xS$ Films in table (2) :

$$\delta= n /D^2 \quad .... \quad (3)$$

$$\varepsilon=\beta_{hkl}\cos\theta/4 \quad ....(4)$$

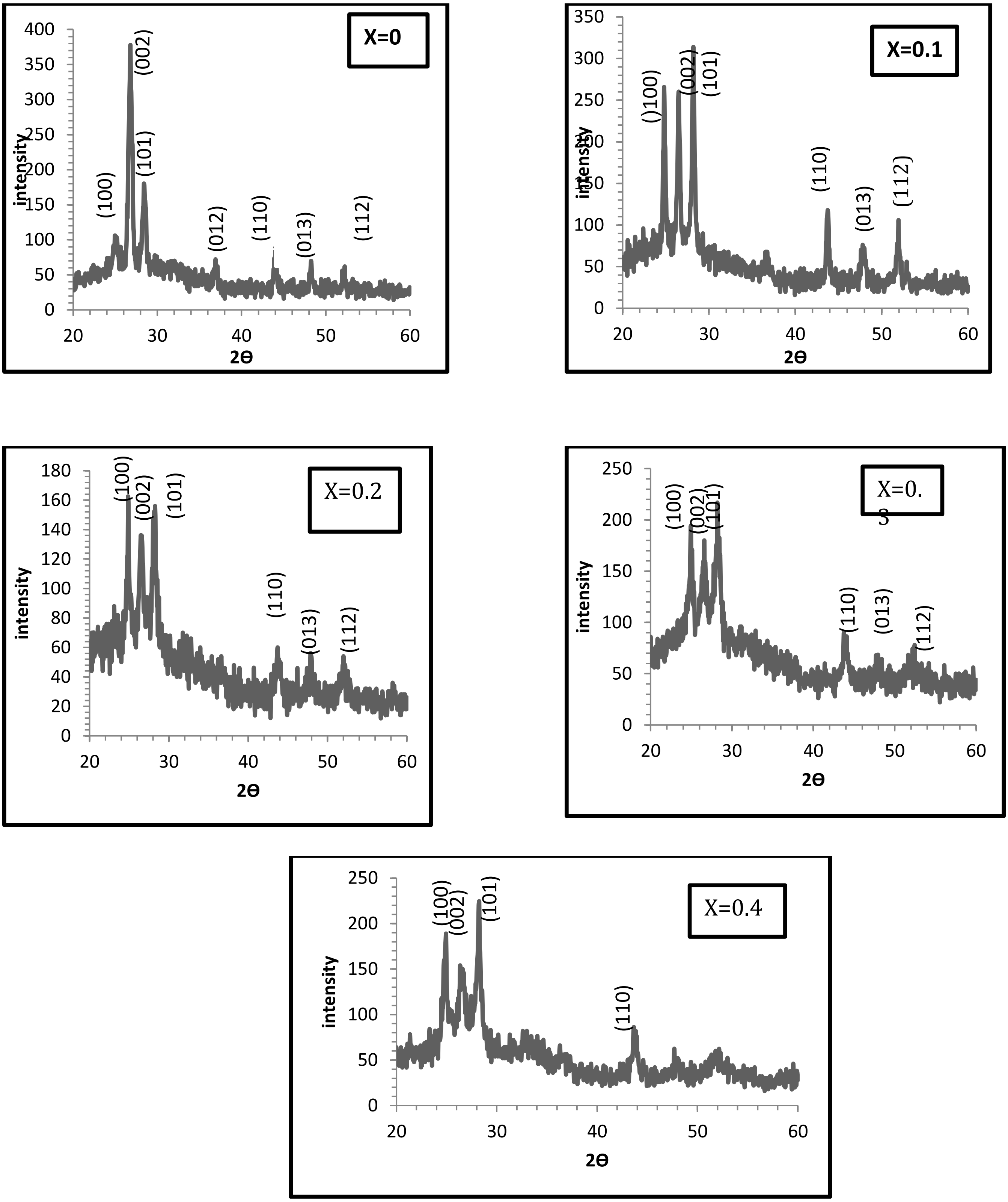


Fig.1. XRD patterns of the $Cd_{1-x}Sn_xS$ thin films

Table (1):The Strucural Parameters Of $Cd_{1-x}Sn_xS$ Thin Film

Film	$2\theta_{stand}$	$2\theta_{expert}$	$dÅ_{stand}$	$dÅ_{expert}$	(hkl)
CdS	26.507	26.814	3.322	3.322	002
$Cd_{0.9}Sn_{0.1}S$	28.182	28.227	3.163	3.158	002
$Cd_{0.8}Sn_{0.2}S$	26.507	26.590	3.359	3.349	002
$Cd_{0.7}Sn_{0.3}S$	28.182	28.302	3.163	3.150	002
$Cd_{0.6}Sn_{0.4}S$	26.507	26.864	3.359	3.316	002

Table(2) :Variation Of the FWHM ,D , ε and δ of $Cd_{1-x}Sn_xS$ Films

Film	FWHM (deg)	DÅ	Strain (rad) $x10^{-3}$	Dislocation density (lines.$Å^{-2}$) x 10^{-5}	$N*10^{-5}$
CdS	0.5333	153.138	2.26	4.264	5.56
$Cd_{0.9}Sn_{0.1}S$	0.5143	159.372	2.17	3.937	4.94
$Cd_{0.8}Sn_{0.2}S$	0.66500	122.854	2.821	6.718	10.786
$Cd_{0.7}Sn_{0.3}S$	0.5729	143.148	2.42	7.66	6.8182
$Cd_{0.6}Sn_{0.4}S$	1.0133	79.095	4.382	15.98	40.418

AFM is an appropriate technique for studying the properties and roughness of the surface of thin films in semiconductors and observing the micro-structure of thin films. The AFM method is one of the effective methods for analyzing the thin film surface, AFM images of the $Cd_{1-x}Sn_xS$ films are shown in Figs.(2)for two and three dimensions . We can observe that membranes are crystallized nature films are interrelated (conformation granules), convergent , spherical shape, and can attribute spherical shape to fixed speed of growth Fig(2) showing the $Cd_{1-x}Sn_xS$ films.

The grain size and the average diameter of $Cd_{1-x}Sn_xS$ films in table (3)

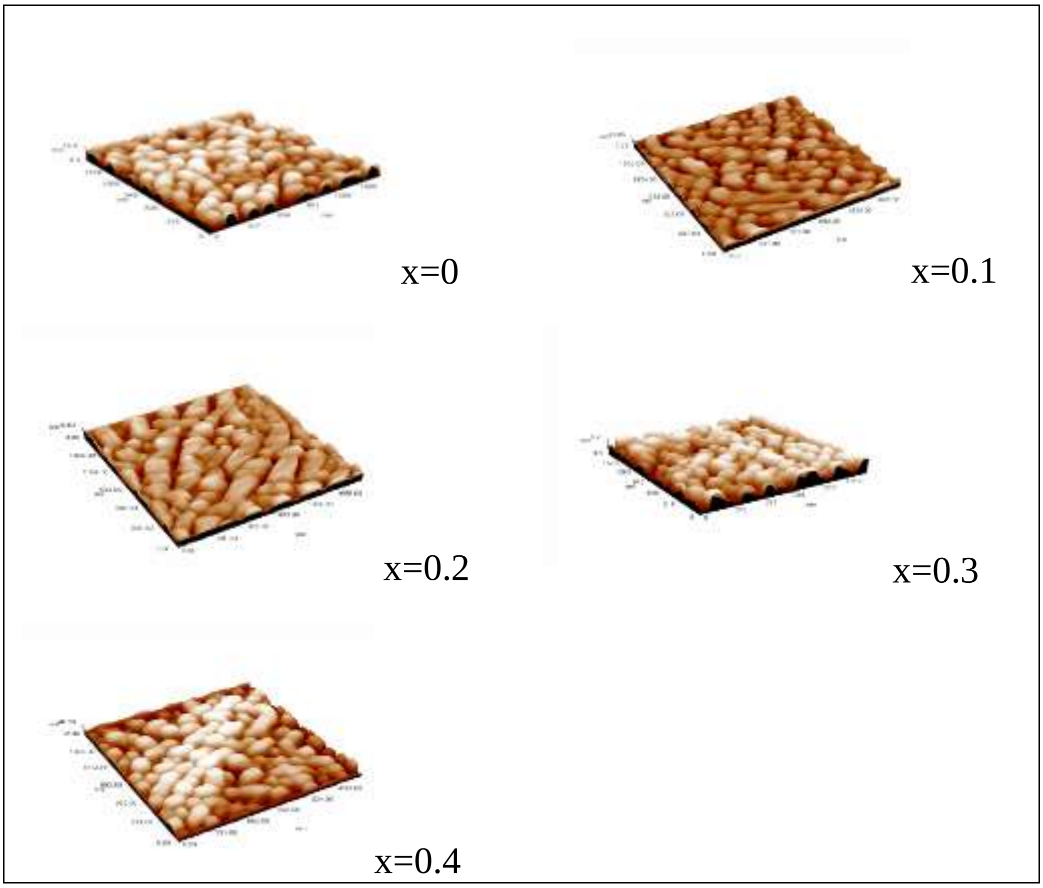
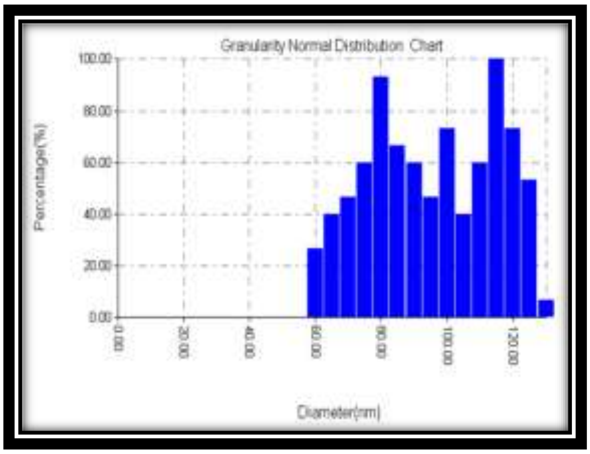
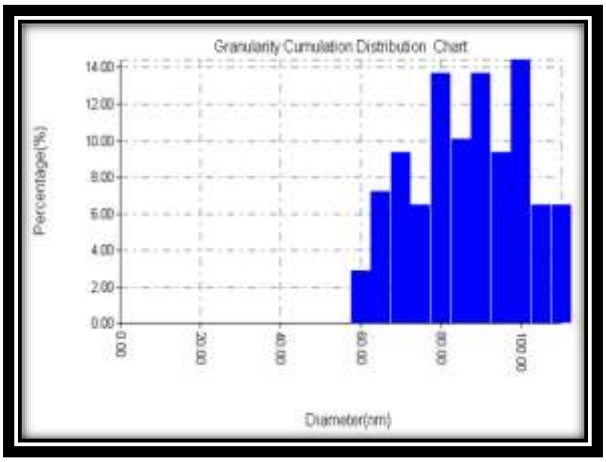


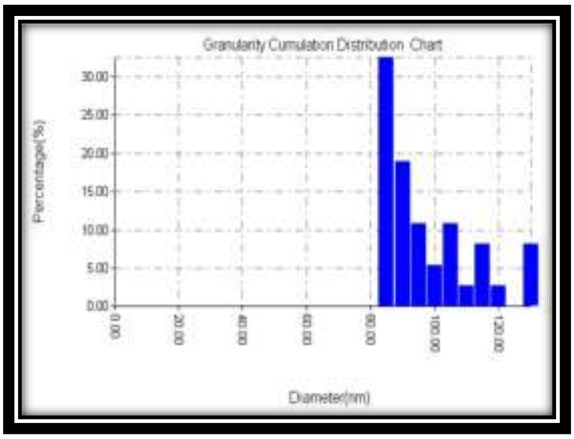
Fig.2 AFM micrographs of $Cd_{1-x}Sn_xS$ thin films.

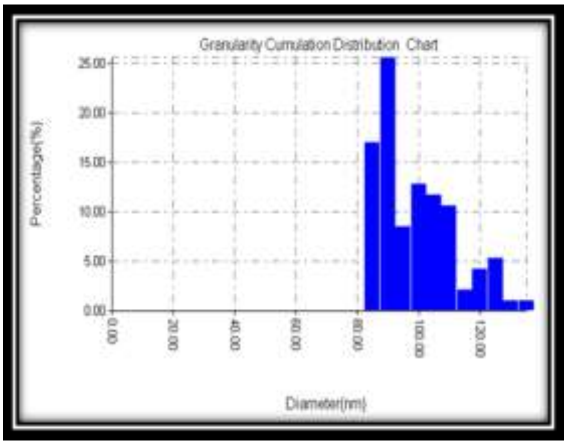
X=0 **x=0.1**





x=0.2 **x=0.3**





X=0.4

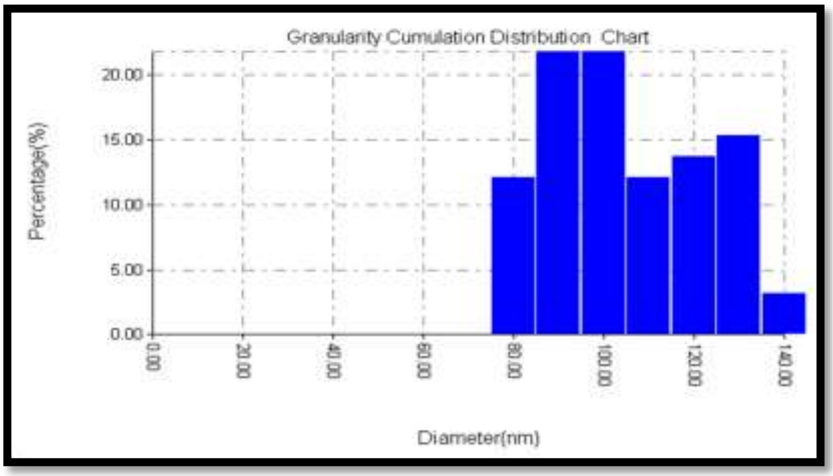


Table 3: Variation of grain size and average diameter , RMS , Roughness of $Cd_{1-x}Sn_xS$ thin films

Film	Grain size(nm)	Avg. Diameter(nm)	RMS	Roughness
CdS	15.38	112.06	11.1	9.63
$Cd_{0.9}Sn_{0.1}S$	24.54	98.21	13.9	12
$Cd_{0.8}Sn_{0.2}S$	14.39	93.15	6.16	5.11
$Cd_{0.7}Sn_{0.3}S$	10.64	105.09	5.35	4.65
$Cd_{0.6}Sn_{0.4}S$	10.17	128.73	3.89	4.41

The optical properties of the $Cd_{1-x}Sn_xS$ thin films were studied. The transmittance & absorption spectra were measured as a function of the wavelength in the region as shown in Fig(3) and (4).

The transmission of $Cd_{1-x}Sn_xS$ where x equal (0 , 0.1 , 0.2,0.3 & 0.4) are shown in Fig.(3). Through the from the same figure that the transmittance decreases with increasing in Sn concentration and this is consider a wide range which can be useful in different application like optical filters . In addition the variation of the transmittance of $Cd_{1-x}Sn_xS$ thin films with the wavelength is very important because this variation will limit the transmitted wavelengths which play an important role in determination the category/type of the optical filters .

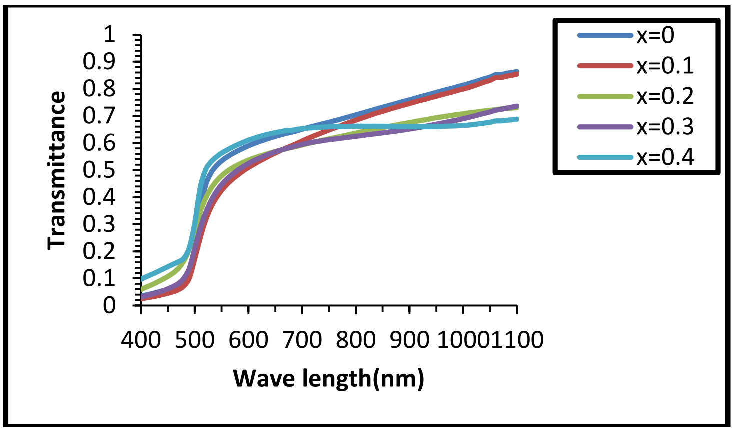


Fig .3. optical transmittance spectra of the $Cd_{1-x}Sn_xS$ thin films.

The absorption spectra is illustrated in Fig.(4) where the effect of the titration on the absorbance spectrum of the $Cd_{1-x}Sn_xS$ membrane shows that the Sn atoms increase the absorption of CdS membranes with increasing wavelengths, which is an opposite effect of the permeability of these films**.**

This increasing in the Absorption is ascribed to the decreasing of the Cadmium concentration (Cadmium posts increase) which effects in an increase of the depth of donor levels related with these vacancies and these levels will be available for the photons to be absorbed therefore the absorbance of $Cd_{1-x}Sn_xS$ thin films will increase with increasing in tin concentration . From this shifting in the absorption edge to the red area it can be realized that the energy gap of $Cd_{1-x}Sn_xS$ thin films will decrease with increasing in Tin concentration .

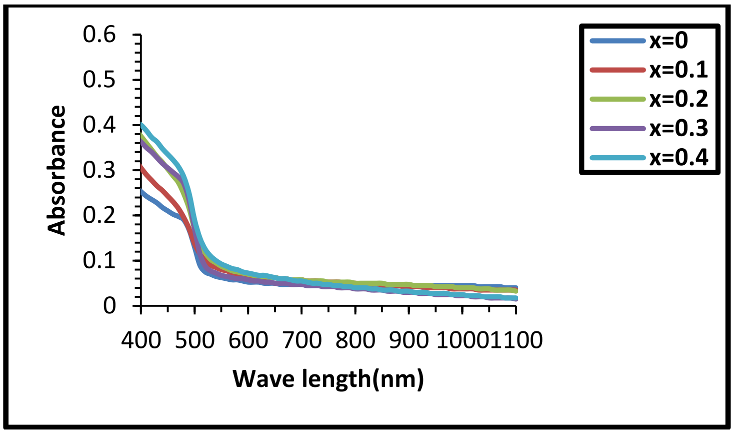
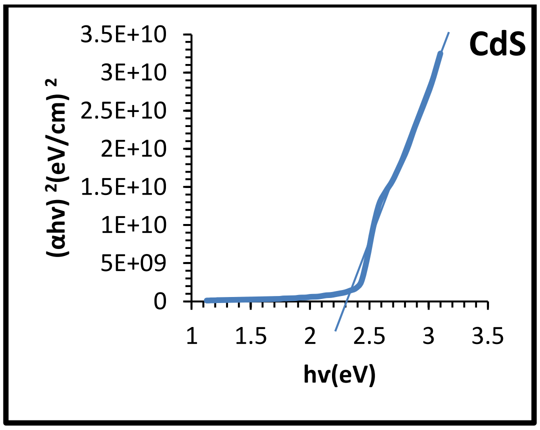
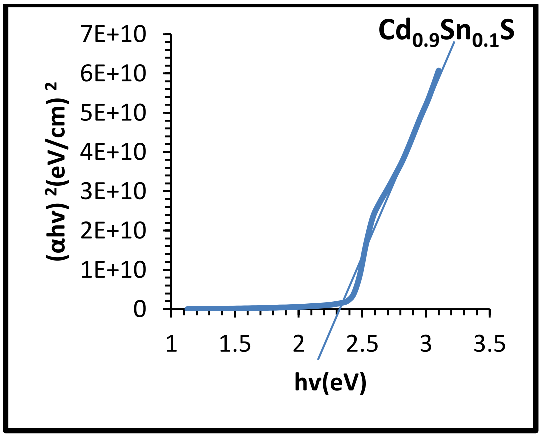


Fig.4.optical absorption spectra of the $Cd_{1-x}Sn_xS$ thin films.

The Optical power gap values for $Cd_{1-x}Sn_xS$ thin films were 3.2 eV, 2.9 eV, 2.8 eV and 2.7 eV for tin concentration (0, 1, 2 and 3) respectively This is attributed to the increasing of Cadmuim concentration (Cadmium Spaces increase) which results increase of the depth of donor steps linked with these vacancies which in turn causing a reduction in the optical power gap for $Cd_{1-x}Sn_xS$. The optical energy gap values for $Cd_{1-x}Sn_xS$ thin films were 2.35 eV , 2.37 eV , 2.38 eV,2.39eV and 2.4 eV for x equal (0 , 0.1 , 0.2,0.3 & 0.4) respectively . The found values of the optical energy gap Conformity well with the stated values of CdS [13] and CdSn [14] .





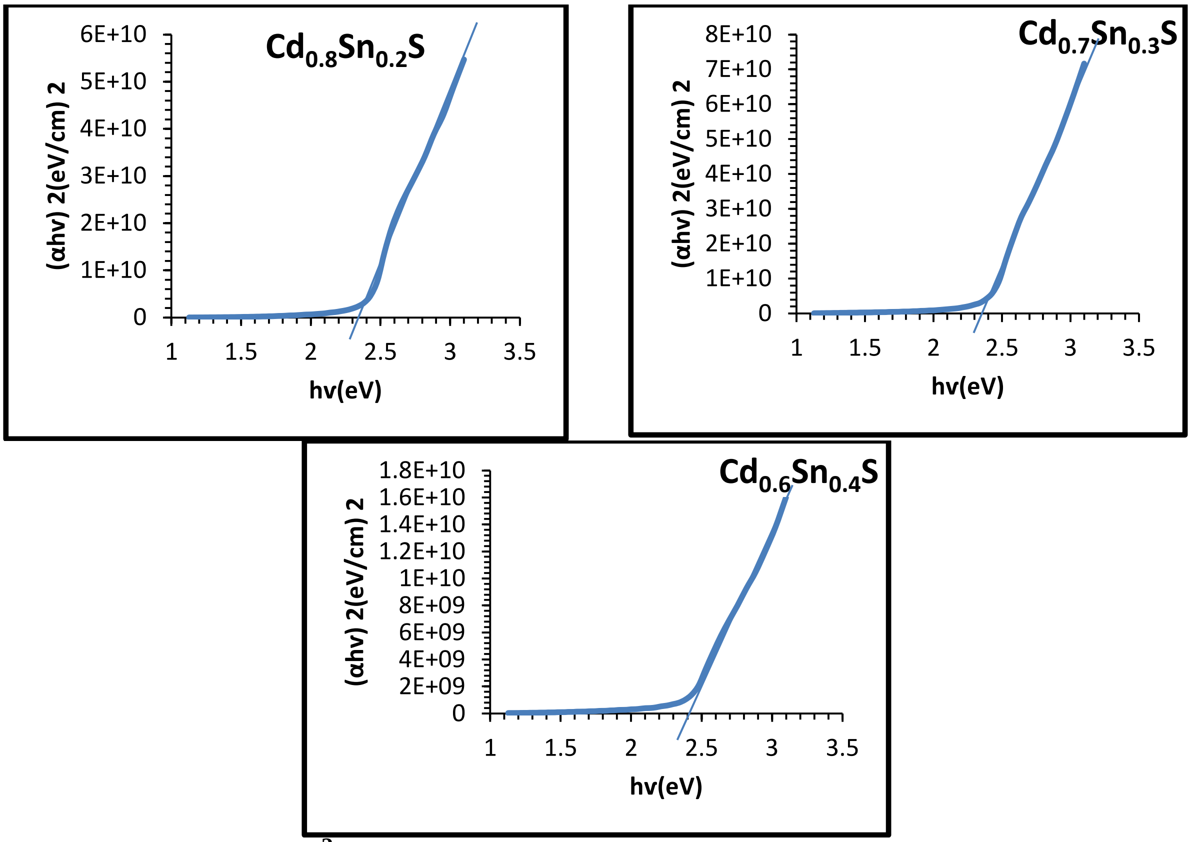


Fig .5. $(\alpha h\nu)^2$ As a function of (hν) for $Cd_{1-x}Sn_xS$ thin films .

4. Conclusion

CdS films were deposited by a spray pyrolysis technique using a solution of cadmium sulphide and thiourea. The films were deposited onto.

Glass substrate at the selected temperature 300 C°.. Substrate temperature during deposition was found to have The crystalline and hexagonal $Cd_{1-x}Sn_xS$ thin films with only (002).

The optical properties of CdS thin films were studied using transmittance and absorbance spectra. The films exhibited a direct transition changes from 3.5 to 2.4 eV.

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