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Effect of Molara Concentration on Structural, Morphological and Optical Properties of CdO Thin Films Prepared by Chemical Spray Pyrolysis Methode

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Abstract: ***Structural, Morphological and optical properties of CdO thin film were presented in this work. The Cadimium Oxide (CdO) semiconducting films are deposited on glass substrate by chemical spray pyrolysis methode. The crystalline structure was studied by X-ray diffraction (XRD) having found the presence of the CdO cubic phase. The AtomicForce Microscopy (AFM) micrographs prove that the grains are uniformly distributed within the scanning areas (2053.41 nm × 2065.63 nm). All samples show an abrupt changein transmission which indicates a direct transition and good crystallinity. Optical absorption measurements showed that films has high absorption coefficient in the UV region, whereas it is transparent in the visible region for CdO film, and it is decreasing and shifted toward the visible region for molarea concentration increas. The direct band gap energy was determined and found to be in the range 2.6 –2 eV.***

Keywords: Cd O, spray pyrolysis technique, structural, Morphological, optical properties

1. Introduction

Transparent Conducting Oxides mainly used in many applications including Electrodes solar cells and flat display panels and windows architectural and photovoltaic [1] . gas sensor, liquid crystal displays, IR detectors and anti-reflection coatings [2].

Vehicles Cdo, Zno has a high transparency in the visible region of the electromagnetic spectrum and Connectivity n-type dating back to oxygen voids[3] Material Cd have energy gap directly its value(2 . 5)eV molecular weight (128.4), density (8.15gm/cm3) and melting point (1773K), and this article acid dissolve and melt alkalitherapy useless. The advantage of this material easily prepared in the form of thin films of good chemical specifications of their solutions, and absorbed a high coefficient so that can be used mainly in solar systems to increase efficiency In photovoltaic cells[4,5], there are several methods of preparation thermal evaporation[6], pulsed laser sputtering [7], activated reactive evaporation [8], sol gel technique[9] spray pyrolysis deposition (SPD) [10] and (SILAR) [1], method were employed to prepare thin films of CdO.

This paper describes the deposition of pure and Different concentrations(0.1,0.15,0.2) M thin films by spray pyrolysismethod. Study of the structural and optical properties of the films through a spectral absorbance and transmittance within the visible region where the optical energy gap and calculate absorption coefficient and other optical constants and the topography of the surface films Aoxd cadmium, using different concentrations .

2. Experimental

CdO films were prepared by chemical spray pyrolysis method on glass substrates at 573 K. Preparation of films (CdO) material cadmium chloride used, $CdCl_2.2H_2O$ and water. cadmium Chloride ($CdCl_2.2H_2O$) was dissolved in a water. Secondly, both solutions were mixed, so that the final concentration was (0.1,0.15,0.2)M. To get the weight to be dissolved within the previous titer used the relationship (1) and mix the solution using a magnetic mixer (Magnetic Stirrer) for min (15-10) to complete the dissolution process, and then leaves the solution for one hour to obtain a homogeneous solution, And then the solution is placed in the spray device tank and sprayed the solution on the heated rules temperature (573K) in the form of payments within a specific time schedule, upon the arrival of the droplets of the solution to the hot-Qaeda surface of the composite steel resulting from the evaporation of water droplets of the solution reacts to the influence of heat to turn into a compound Last, and constantly spraying process chemical reactions continue to produce film (CdO).

$$M = (W_t / M_{Wt}). (1000/V) \quad \ldots\ldots\ldots\ldots (1)$$

Molara concentration (mol/l) : M
weight (g): W_t
M_{wt}: Molecular weight of the material (g/mol)
Distilled water is the size of which has a Dissolving: V

3. Result and Discussion

3.1X-ray Characterization

The X-ray diffraction (XRD) patetern of the CdO thin films deposited on glass substrate is illustrated in Figure (1): the figur reveals a polycrystalline structure of the film. In this diffraction pattern, the peaks at 2θ (32.4, 38.6, 55.2), (32.8, 38.4, 55.6), (32.6,38.8,55) correspond to diffraction from (111) and (200) and (220) planes of the CdO cubic phase, respectively. This result is comparable with results obtained by [2,7, 9, 10]. It is apparent from this figure that all films are preferentially orientated along (111) crystallographic

directions and the preferential orientation peak for incres Molara concentration of the film became sharper and more intense. This may be attributed to the crystallinity of the CdO film being improved with incres Molara concentration.

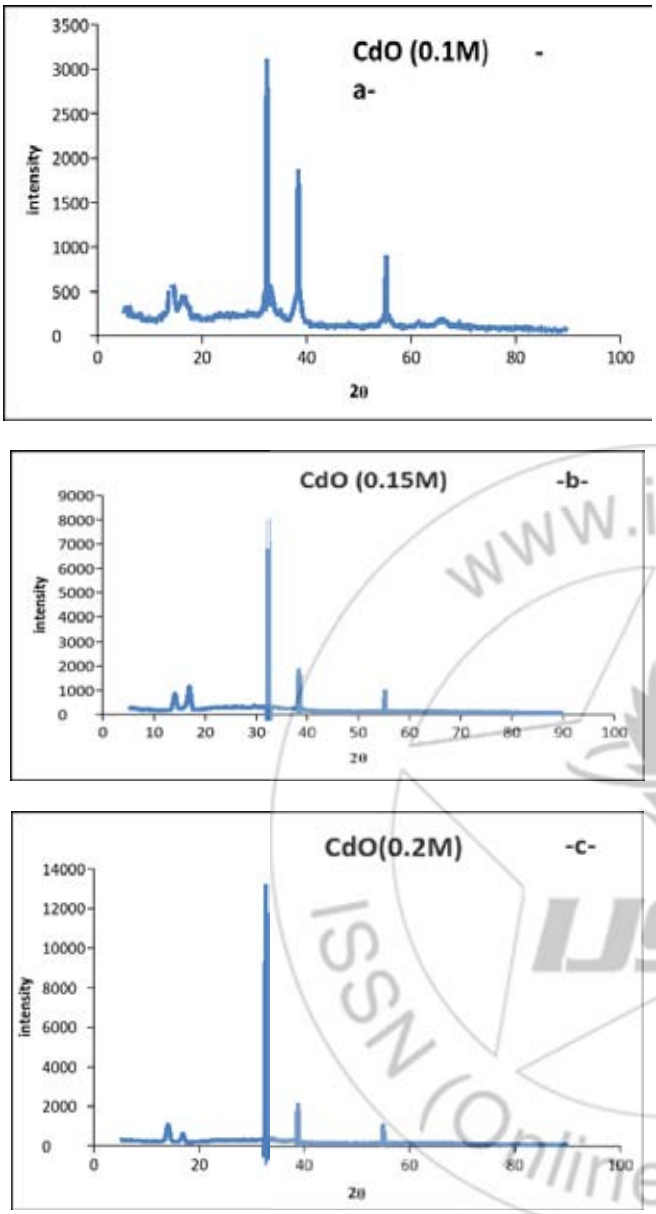

Figure 1: XRD patterns of CdO thin film

Table 1: The Strucural Parameters of CdO thin film

Molara concentration	2θ Exp .(deg)	2θ Stan .(deg)	d Exp.(A°)	d Stan.(A°)	(hkl)
0.1	32.4	33.001	2.7614	2.712	111
	38.6	38.285	2.344	2.349	200
	55.2	55.258	1.6628	1.661	220
0.15	32.8	33.001	2.7285	2.712	111
	38.4	38.285	2.344	2.349	200
	55.6	55.258	1.6517	1.661	220
0.2	32.6	33.001	2.7439	2.712	111
	38.4	38.285	2.3517	2.349	200
	55	55.258	1.6683	1.661	220

Grain size was calculated by compensation values that were obtained from the X-ray diffraction results of the previous figures in the equation of Sherrer [11]

$$G.S = \frac{k\lambda}{\beta \cos\theta} \quad \ldots\ldots\ldots\ldots (2)$$

where G.S: is the grain, *K:* is a constant (0.94), λ: is the wavelength of Cu Kα , θ: is the Bragg's angle, and β:is the Full Width at Half Maximum (FWHM).

The lattice constants calculated from the following equation [12] .

$$d = \frac{a}{\sqrt{h^2+k^2+l^2}} \quad \ldots\ldots\ldots\ldots (3)$$

Where,

d : is the interplaner distance.

hkl : miller indices .

a : lattice constants .

The calculated values of lattice constants for CdO thin films are in good agreement with ASTM data.

The value of the dislocation density (δ) which gives the number of defects in the film was calculated from the average values of the crystallite size *D* by the relationship [13] .

$$\delta = \frac{1}{D^2} \quad \ldots\ldots\ldots\ldots (4)$$

The strain (ξ) developed in CdO thin films can calculated from the relation [14] .

$$\xi = \frac{\beta \cos\theta}{4} \quad \ldots\ldots\ldots\ldots (5)$$

Table 2: Variation of The Full Width at Half maximum , Grain Size , Lattice Constants, Dislocation Density and Strain of CdO thin Film

Strain (rad) x 10^{-3}	Dislocation density (lines.$Å^{-2}$) x 10^{-5}	Lattice Constants a(Å)	Grain size (nm)	(FWHM) (rad)	Molara concentration
1.2815	1.3676	4.7828	270.4916	0.005338	0.1
1.1797	1.15825	4.7260	293.833	0.0049194	0.15
1.1803	1.15941	4.75274	293.6838	0.004919	0.2

Atomic force microscopic (AFM) allows us to get microscopic information on the surface structure and to plot topographies representing the surface relief. This technique offers digital images which allow quantitative measurements of surface features, such as root mean square roughness, *Rq*, or average roughness *Ra*, and the analysis of images from different perspectives, including three-dimensional simulation [15]. AFM images of the CdO films are shown in Figs. 2 for two and three dimensions. It can be observed that the films exhibit a polycrystalline nature membranes are interrelated (conformation granules), convergent , spherical shape, and can attribute spherical shape to fixed speed of growth .The grain size and the average diameter of CdO films are listed in table (3) .

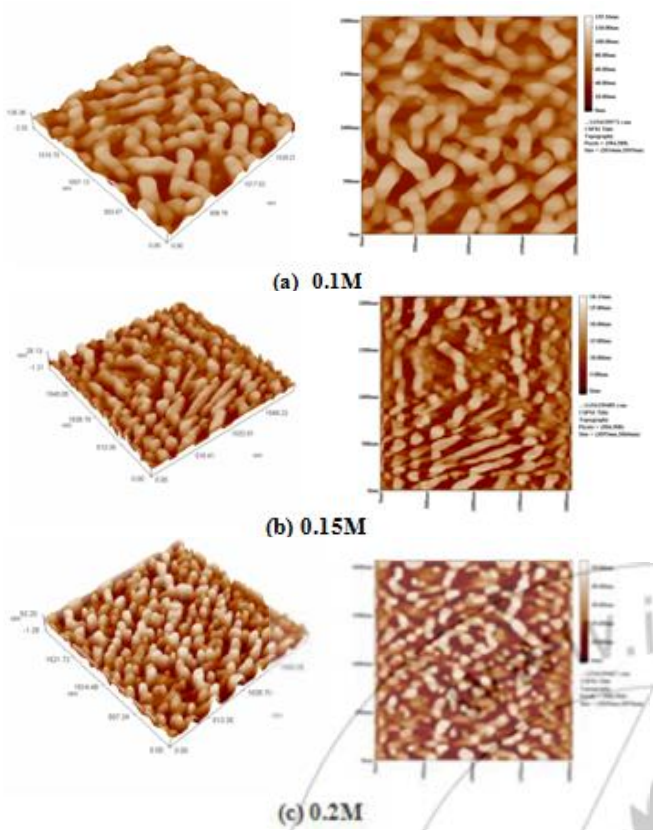

Figure 2: AFM micrographs of (a)CdO(0.1M) , (b)CdO(0.15M) (c) CdO(0.2M) films.

Table 3: AFM parameters of CdO thin films with thickness of 200 nm

grain size (nm)	RMS [nm]	Molara concentration
86.50 nm	20.2	0.1
97.00 nm	5.35	0.15
84.27 nm	13.9	0.2

3.2. Optical properties

The optical absorption of CdO films deposited onto a glass substrate was studied in the range (300–900) nm. Fig. (3) shows the variation of absorption with wavelength. The absorption of the film is found to increase after Molara concentration increase. This is possibly due to increase in crystalline nature and decrease in the number of defects in the localized state [16].

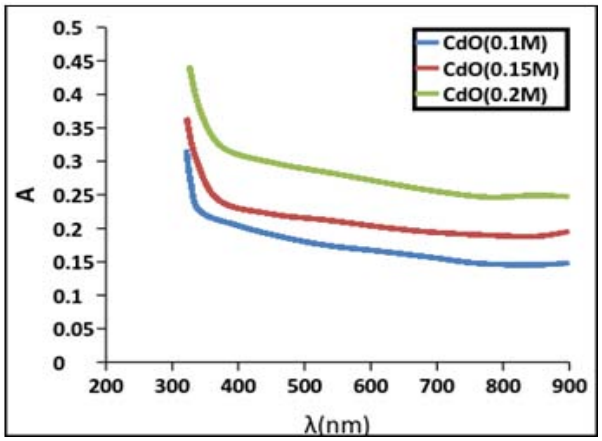

Figure 3: Absorbance spectrums of CdO thin film

Figure (4) shows the optical transmittance spectra with wavelength from 300 nm to 900 nm of the CdO thin films. The optical transmittance decreases for incres Molara concentration of the film CdO film.

Assuming direct transition, the dependance of $(\alpha h\nu)^2$ on the photon energy hν is plotted following Tauce relation [17, 18] and the graph is illustrated in Figure (5).

The extrapolation of the linear part of the above plot to $(\alpha h\nu)2 = 0$ gives the energy gap values of the CdO films, which were found to be about (2.6) and (2) eV respectively. It can be noticed from this figure that the value of energy gap is decreasing for incres Molara concentration of the film CdO film. These values are in a good agreement with the values presented by other workers [7,9]

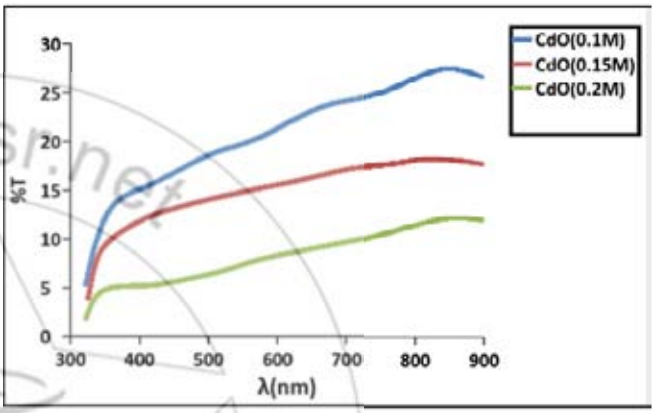

Figure 4: Transmission spectrum of CdO thin film

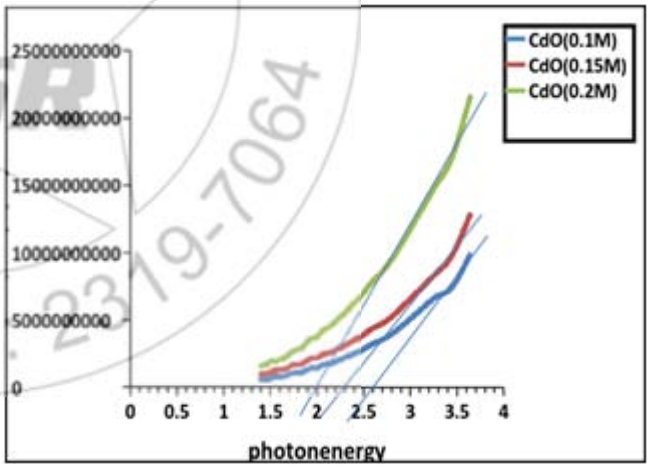

Figure 5: (αhυ)2 as a function of hυ for CdO thin film

4. Conclusions

- The CdO thin films have been successfully deposited onto glass substrates using the spray pyrolysis deposition (SPD).
- XRD shows that the films have a cubic crystal structure. The average G.S. of (1 1 1) orientation studied polycrystalline
- film at Molara concentratio (0.1)M was found to be around 270.4916 nm and after increases Molara concentratio (0.15,0.2)M G.S. was found to be around (293.833, 293.6838) nm
- The band gap value of CdO decreases from 2.6 eV to 2 eV

with increases Molara concentration.

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