Journal of Multidisciplinary Engineering Science Studies (JMESS)
ISSN: 2458-925X
Vol. 2 Issue 9, September - 2016

Effect of Molarity on Optical Properties of Cadmium Oxide Thin Film Prepared By Chemical Spray Pyrolysis

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***Abstract*—CdO thin films were prepared by a spray pyrolysis technique on glass substrate from a solution of cadmium acetate dehydrate with various molarity to prepare thin films. Optical measurements show that the absorbance of these films increase with the increasing molarity concentration and decrease with the increasing wavelength. The optical energy gap is increased from 2.38 eV for the film prepared with 0.05 M to 2.40 eV for the film prepared with 0.10 M of CdO thin films. In addition, the absorption coefficient, extinction coefficient, and refractive index are calculate.**

Keywords—Cadmium Oxide , CdO thin films , TCO , IR energy gap,

Introduction

The CdO thin film is animportant semiconducting material with a high electrical conductivity and high optical transmittance and has an n-type semiconductor with a band gap changing in the range of 2.2–2.8eV [1-3]. These films have been widely studied for opto electronic application sintrans parent conducting oxides(TCO), solarcells, smart windows, optical communications, flatpanel displays, photo-transistors, as well as other types of application slike IR heat mirror, gassensors, low-emissive windows, thin-film resistors, etc[4-7].The seinteresting materials have been prepared by the sol–gel process[8], spray pyrolysis[4,9,10], pulsed-laser deposition[11], molecularbeam epitaxy[12], DC reactive magnetron sputtering [13],co-evaporation[14,15], and plasma-enhanced metal organic chemicalvapor deposition[16].

The Cadmium Oxide thin films were deposited using chemical spray pyrolysis technique, and via UV-Visible spectrophotometer, the absorbance spectra are recorded to investigate some of optical properties.

Experimental Procedures

The spray pyrolysis was done by using a laboratory designed glass atomizer.Cadmium acetate dehydrate $Cd(Ch_3Coo)_2.2H_2O$ supplied from Sigma-Aldrich Chemicalsused with various molarity to prepare thin films which have an output nozzle of 1 mm. The films were deposited on preheated glass substrates at a temperature of 400°C with the optimized conditions that concern the following parameters: spray time was 8 sec,the stopping period 2 minutes, this period is enough to avoid excessive cooling of glass substrate,the carrier gas (filtered compressed air) was maintained at a pressure of 10^5 Pascal,distance between nozzle and substrate was about 28cm, solution flow rate5ml/min. Thickness of the samples 350 nm measured by gravimetric method.

UV-Vis spectrophotometer used to record the absorbance spectra in the wavelength range (300-900nm).

Results and Discussion

Fig.1 shows absorption spectra of CdO thin films with various molarity concentration in the range of 300-900 nm. From the figure, the absorbance increases with increasing molarity concentration and decreases with increasing wavelength for all deposited thin films.This behavior attributed to the increasing of number of Cd atoms lead to increasing the number of collisions.

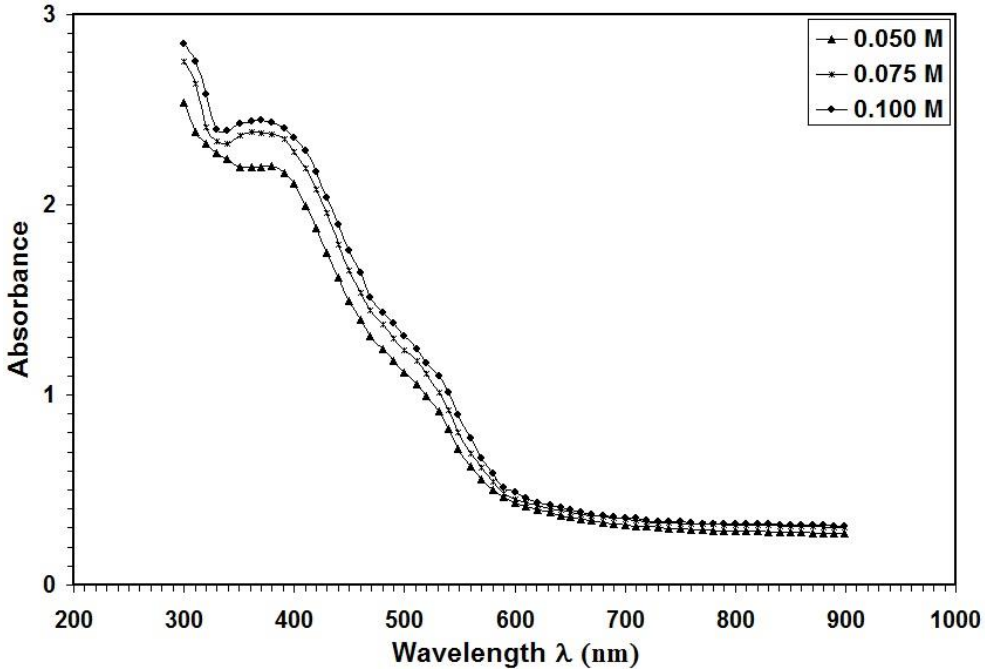

Figure 1. Plot of absorbance of CdO thin film as a function of wavelength.

The absorption coefficient (α) was calculated from the relationship [17]:

$$\alpha = 2.303\frac{A}{t} \qquad (1)$$

where A is the absorption and t is the thickness. The absorption coefficient for various molarity concentration versus photon energywere presented in Fig.2 for CdO thin films. The absorption coefficient was increased with the increasing of photon energy and molarity concentration. The values of α for all prepared thin films are greater than $10^4 cm^{-1}$, which refer to the direct allowed transition.

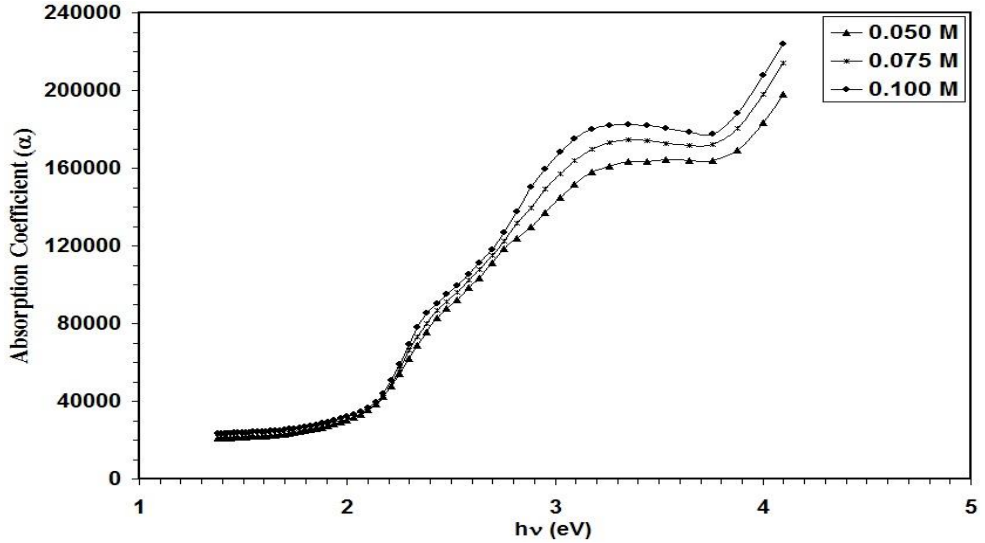

Figure 2. Plot of absorption coefficient of CdO thin film as a function of photon energy.

Fig.3 shows the variation of extinction coefficient (k) with wavelength. The extinction coefficient decreases with the increasing of wavelength and the concentration of molarity of the prepared CdO thin films.

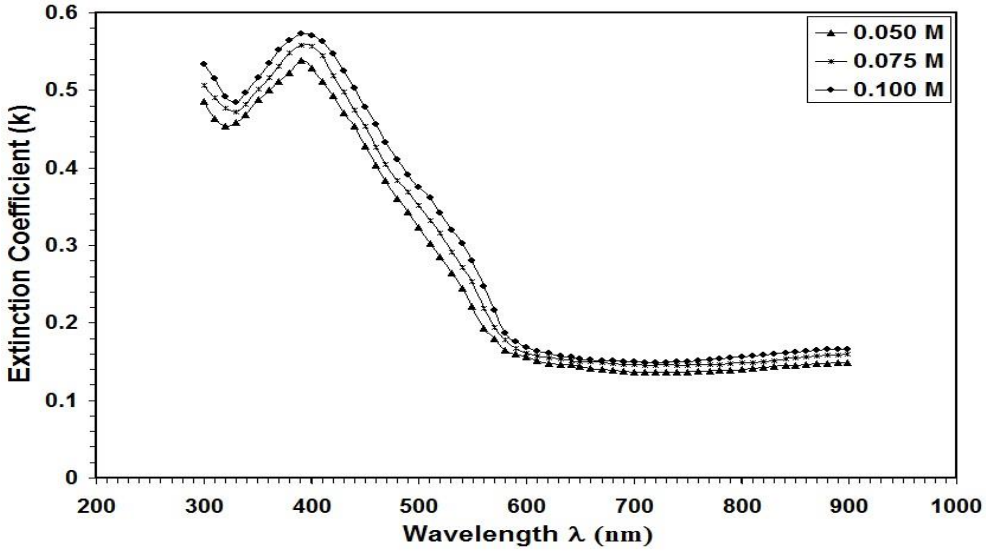

Figure 3. Plot of extinction coefficient of CdO thin film as a function of wavelength.

The variation of refractive index (n) with wavelength is presented in Fig.4. From the figure, it can notice the increase of refractive index with increasing of wavelength until 570 nm and then decreases for all deposited thin films, and increase with the increasing of concentration of molarity. This behavior refers to the decrease of transparency.

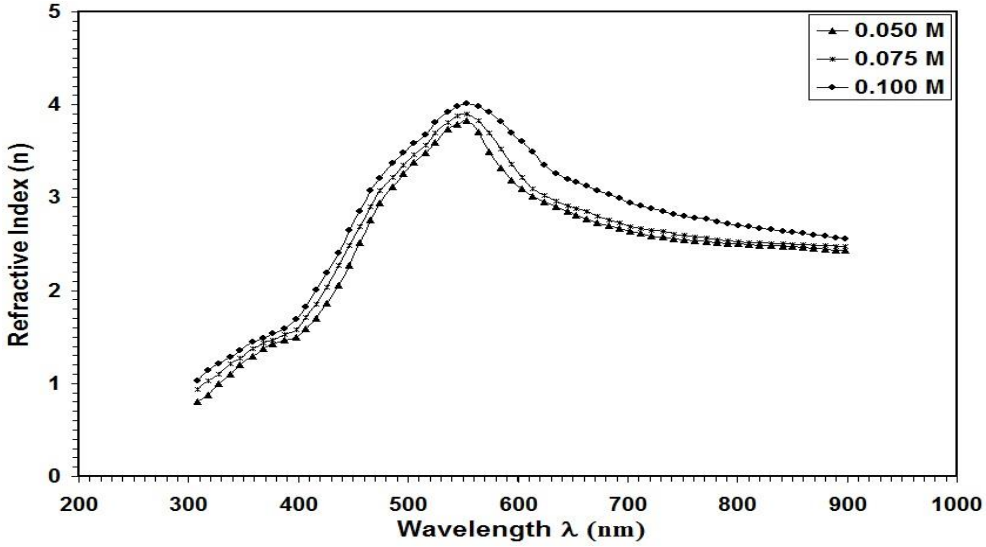

Figure 4. Plot of refractive index of CdO thin film as a function of wavelength.

The relation between absorption coefficient (α) and the incident photon energy (hυ) is given by the following relation [18]:

$$(\alpha h\nu) = A\left(h\nu - E_g\right)^{\frac{1}{2}} \quad (2)$$

For allowed direct transition, n = ½, and E_g is the energy gap that determined from the extrapolating the straight line to cut the x-axis as shown in Figs.5-7. From the figures, the energy gap is increased from 2.38 eV for the film prepared with 0.05 M to 2.4 eV for the film prepared with 0.10 M of CdO films.

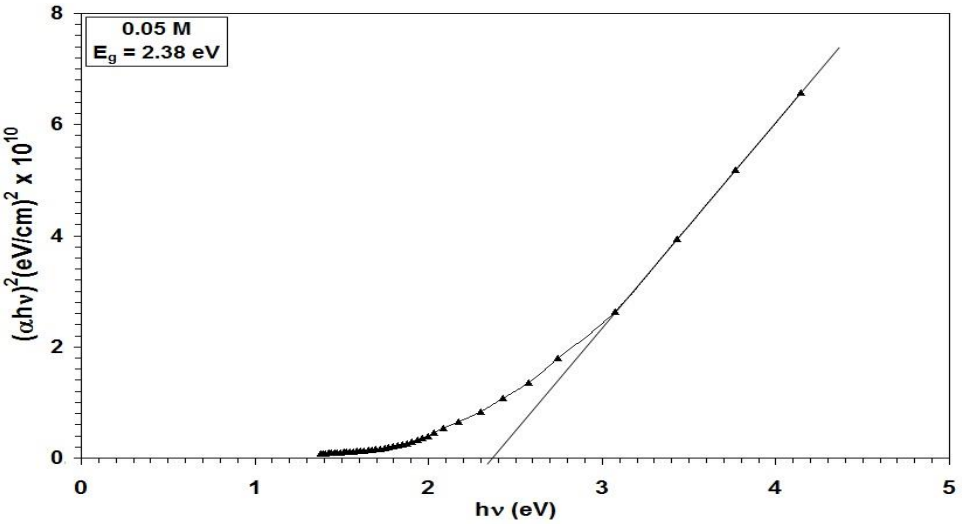

Figure 5. Plot of $(\alpha h\upsilon)^2$ of 0.05M of CdO thin film as a function of photon energy .

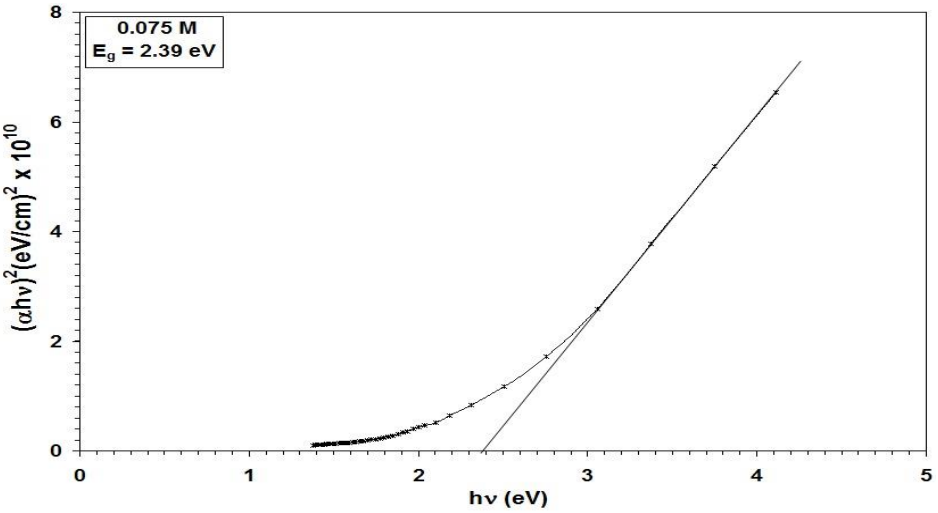

Figure 6. Plot of $(\alpha h\upsilon)^2$ of 0.075M of CdO thin film as a function of photon energy .

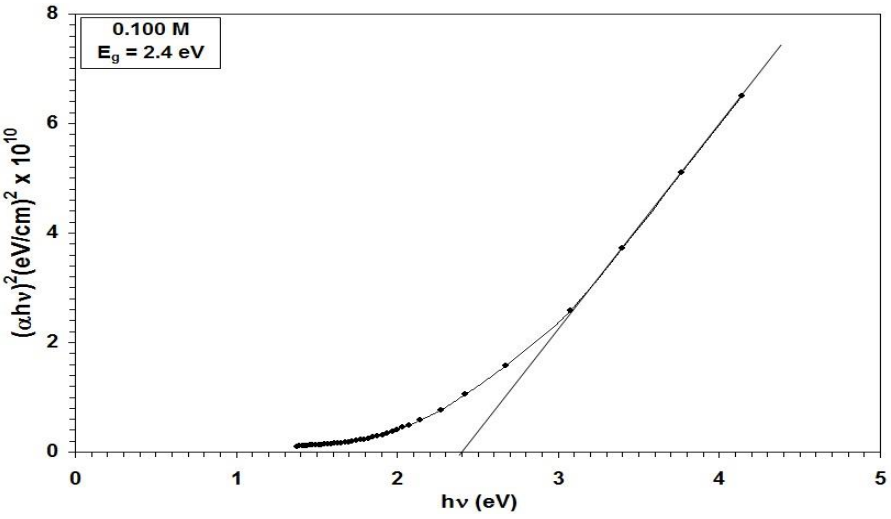

Figure 7. Plot of $(\alpha h\upsilon)^2$ of 0.1M of CdO thin film as a function of photon energy .

Conclusion

The optical analysis show that spray pyrolysis technique is a useful method for the deposition of CdO thin films. From the optical measurements, the film absorbance was increased with the increasing molarity concentration and decrease with the increasing wavelength. While the optical energy gap is increased from 2.38 eV for the film prepared with 0.05 M to 2.40 eV for the film prepared with 0.10 M of CdO thin films

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