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Effect of thickness on some optical properties of Spray pyrolysed Cdo thin films

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Abstract

In this research, the study of some optical properties such as, (reflectance, refractive index and dielectric constant in its two parts) were calculated of cadmium oxide thin films prepared by the chemical spray paralysis and precipitated on glass substrates heated to (723K), also, the study of the effect of thickness on these properties.

الخلاصة:

تم في هذا البحث دراسة وحساب بعض الخواص البصرية المتمثلة بـ (الانعكاسية، معامل الانكسار، معامل الخمود وثابت العزل الكهربائي بجزيئه الحقيقي والخيالي) لأغشية أوكسيد الكادميوم(CdO) المحضرة بطريقة الترسيب الكيميائي الحراري والمرسبة على قواعد ساخنة من الزجاج بدرجة حرارة (723K)، وتأثير السمك على تلك الخواص.

Key Words: spray pyrolysis, Cdo thin films, optical properties

Introduction

Oxide cadmium has a crystal structure from central faces like Nacl structure with lattice constant abut (a=4.69Å) and partial weight abut (128.4 g/m), density (8.15 g/cm3)[1] . Cdo has n-type degenerate semi conducting properties with band gap of 2.2-2.6 eV. [2].It considers from materials that can't analysis in water, Acid and substrates. But it anlysises in Acids nashader salts [3]

According to high transparency of films in a visible near in infrared region. It is classified according to transparent conduction oxides which has high applications in electroptical [4]. The films that we obtain by chemical spray pyrolysis technique (CSPT) can be usful for the science researches and technical applications. This is a good economic ways to get on analyses and metals salts [5]. The target of this research is studying some optical properties for cadmium oxide and thickness effect on these properties in order to find the best thickness to obtain on the best properties.

Experimental Work

First: - Cd(No3)24H2o material is used for getting on cadmium oxide (0.2M) .Deposition is used to obtain on a good film . It has been found that the following deposition parameters give good stoichiometric form surface:-

1) Substrate Temperature of about (723K).
2) Spray rate 10 cm3/min.
3)Air pressure (105N/m2)
4) Distance between sprayer nozzle and substrate of 30+1 cm

Preparing films are sprayed on borcilecat glass substrate after cleaning it and putting it on electrical heater about (30min) before spraying process so the glass substrates are nearly at the same temperature as the electric heater. Each spraying period lasts for about (15 sec) following by about (5min) waiting period to avoid excessive cooling of the hot substrates duo to the spraying. The film were clear, transparent, brown colored having very good adhesive properties and are smooth surface free from pinholes. by using weighting method and electronic balance (Metter AE-160).The thickness of preparing films were in the range of (0.2,0.3,0.4)nm

Second:-Optical measurements were concluded to record both spectrophotometer absorbance and Transmition for wavelength between (280-900) nm by using this type (PU-8800-UV/VIS Spectrophotometer) with two bands whish is provided by philips company. Put the glass substrate like the glass that used for spraying in the back window, and then put the deposited film in to were source window .All the processes were happened in the room temperature.

Results and Discussion

Fig. 1 shows the X-ray diffraction (XRD) measurements demonstrated that the Cdo thin film is a polycrystalline structure, the dominant orientation (111), and this is agree with (ASTM) cards. Fig. 2 shows the relation between absorbance and photon energy, we found the behavior of curves is the same for each curves. The rapid increase of the a absorption in the low energy and sudden increase in special energy , this is refer to electronic transition , and this increase is continuous with the increase of photon energy , The effects of thickness , absorbance value increased with thickness increase and this agree with relation :-

$$\alpha = 2.303\frac{A}{d} \quad \text{...(1)}$$

When:

Absorption

d- Thickness

α - Absorption coefficient

Fig. 3 shows the relation between transparent and photon energy, we had been found rapid decrease in low energies and sudden decrease in special energies and it continuous with decrease in high energy, thickness increase refers to the decrease in transparent value.

The reflection were calculated depended energy safe law using the relation: [7]

R + T+ A = 1 ………………………………. (2)

When:

R- Reflection

T- Transmition

Fig. 4 shows the relation between reflection and photon energy. we had been found rapicl increase in reflection value .until to arrive to peak, then it reduce from high energy because of less absorption in low energies from energy gap Transmition decreasing due to reflection increasing using the relation (2) .At high energies from energy gap, the a absorbance is increasing, this cause the reduce in reflection, and the upper corresponding energy gap value (2.2-2.6)ev . Increasing of thickness due to minor change in to peak curves, it is shifted low energies.

In depended on conclusion absorption value in relation (1), coefficient was measured by using relation: [8]

$$K_0 = \frac{\alpha\lambda}{4\pi} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Ko – Extinction coefficient

λ - Wave length

And the fig. 5 show the relation between extinction coefficient and photon energy . It was found that the decreasing at extinction coefficient value with increase of thickness because of decreasing absorption coefficient value with increase of thickness like relation (1)

And the fig. 6 shows the relation between refractive index and photon energy, during our showing to curves we notice that the behavior f curves is the same each samples Refraction index is increasing with increasing of photon energy until it arrives peak at photon energies (2.2-2.6) ev .Then it began to decrease, thin in flucial shows during curves peak shifted at low energy with increasing of thickness. This behavior is the same as reflective change with thickness according to a great connection between reflection and reflective index.

Reflective index is measured by this relation: [9]

$$n_o = \left[\left(\frac{1+R}{1-R}\right)^2 - \left(k_o^2 + 1\right)\right]^{\frac{1}{2}} + \frac{1+R}{1-R} \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

no- Reflective index

Due to dielectric constant with its part real and imaginary, they measurement according to relation: [9, 10]

ε 1= no2-ko2 ………………………………………….. (5)

ε 2 = 2 no ko ……………………………………………. (6)

ε 1 - real part of dielectric constant

ε 2 – imaginary part of dielectric constant

Fig. 7 shows the relation between real part of dielectric constant and photon energy we were found refraction index curve. This result is depended on refraction index in relation (5) and we saw that the peak of curves is shifted to low energies with thin increasing. Fig. 8 shows the relation between imaginary part of dielectric constant and photon energy , and we were found the similarity between this relation and extinction coefficient curve because of it`s in depend on extinction coefficient with great degree like relation (6).

Conclusion

1. Cdo thin film is a polycrystalline structure , the dominant orientation (111)
2. thickness increase refers to the increase in absorption value
3. Thickness increase refers to the decrease in transparent value.
4. Increasing of thickness due to minor change in to peak curves, it is shifted low energies.
5. curves peak shifted at low energy with increasing of thickness

Reference

[1]. Z.M. Jarzebski “Oxide Semiconductors”, Pergoman Press, ***(1973).***

[2]. A.A. Dakhel , "solar Energy ", 4 January 2008 .

[3]. معجم ومصطلحات العلم والتكنلوجيا و مهعد الانماء العربي 1982.

[4]. T.K.Subrayman , B.Srinivasulu and S.Utnanna , Cryst.Res. Technol., 35,10,1193***(2000).***

[5]. N. Benramdane, WA. Murad, RH.Misho, M.Ziane and Z.Kebbab, Materials Chmistry and physics , 48,2,119-123(1997).

[6]. N. Benramdane, WA. Murad, RH.Misho, M.Ziane and Z.Kebbab Materials Chmistry and physics , 48,2,119-123(1997).

[7]. K.L. Chopro. , "Thin Film Devices Application ", plenum press New York 1983 .

[8]. J. Mullerova and J.Modron ,J.Acta.phyica Solvaca ,50,4, 477 (2000).

[9]. H.H.Dass,N.F.Habubi ,Journal of The College Education ,4 *(1999)*

[10]. A.A.M. Shehab, Ph.D.Thesis, Unversity of Baghdad, ***(1998).***

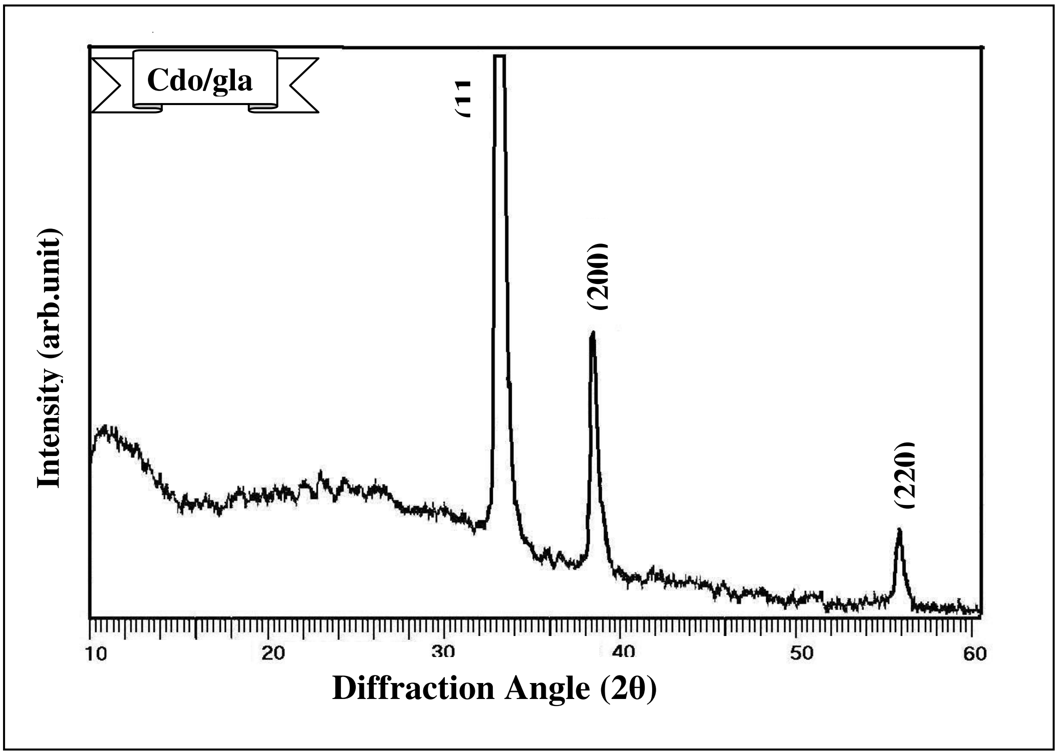


Figure (1) X-ray diffraction for Cdo thin film on glass

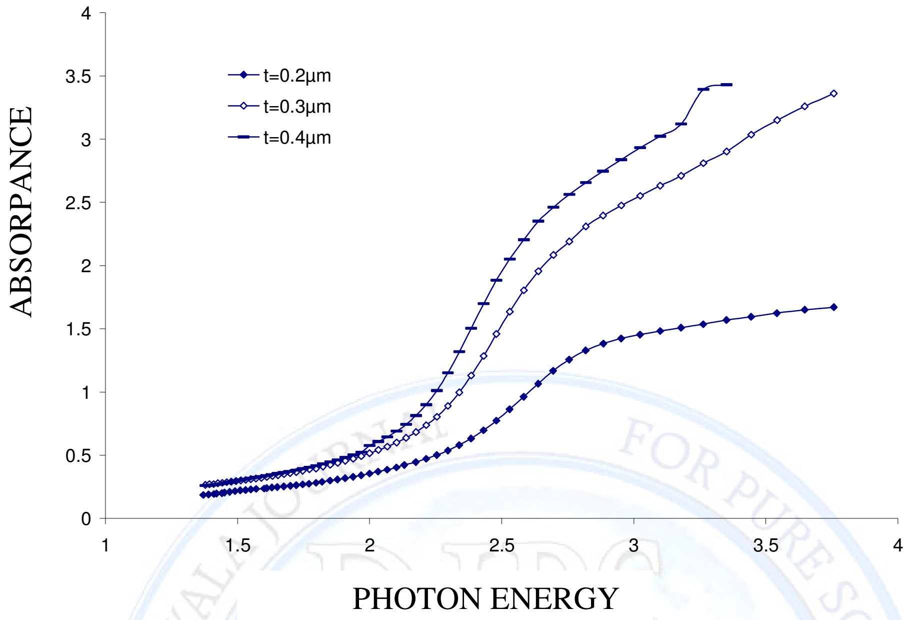


Figure (2) Absorbance with Photon energy

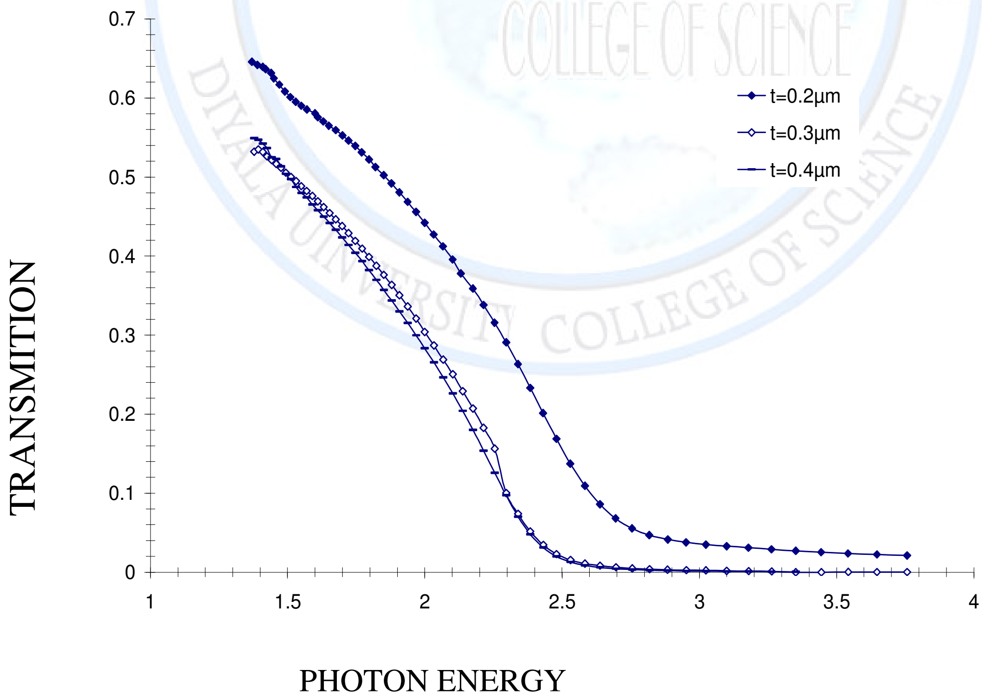


Figure (3) Transition with Photon energy

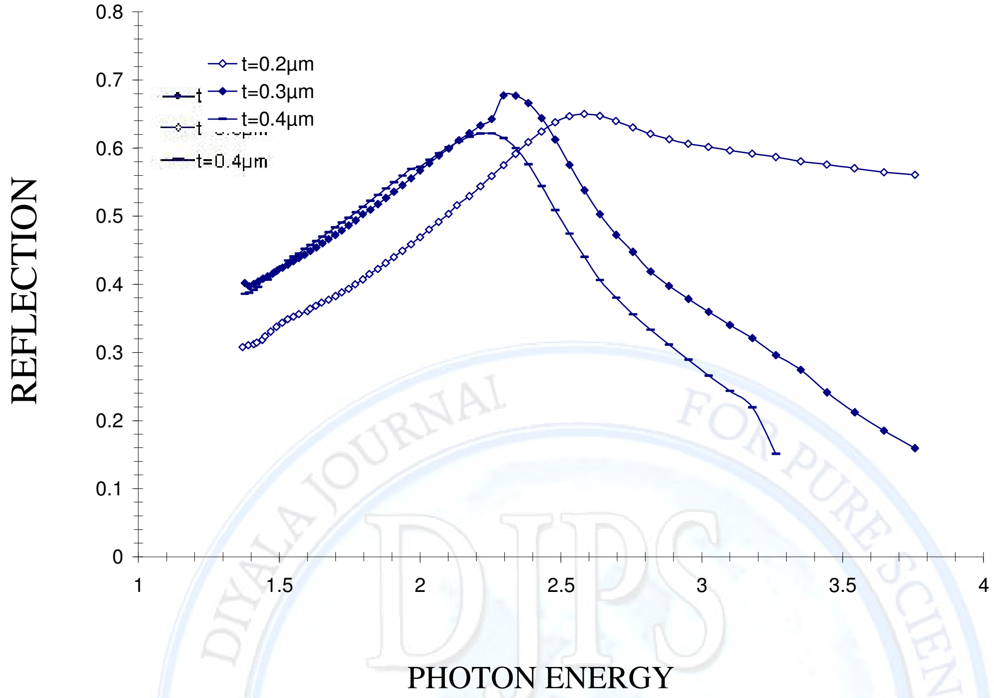


Figure (4) Reflection with Photon energy

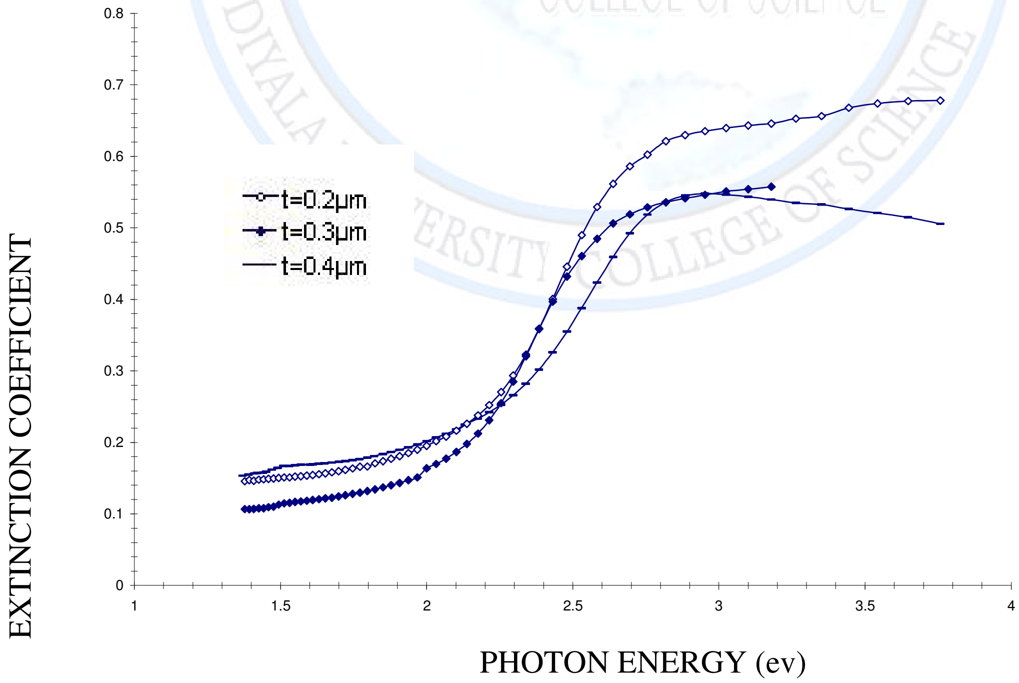
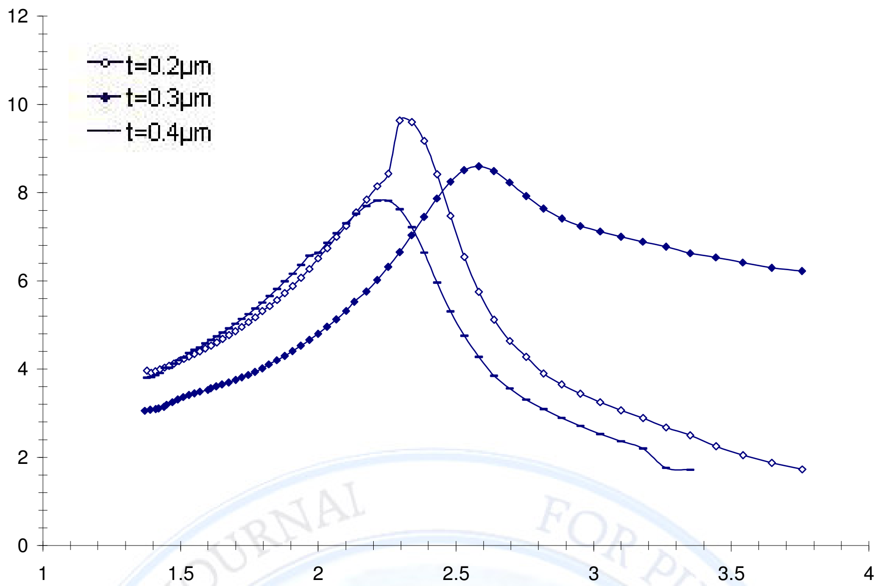


Fig.(5) Extinction with Photon energy

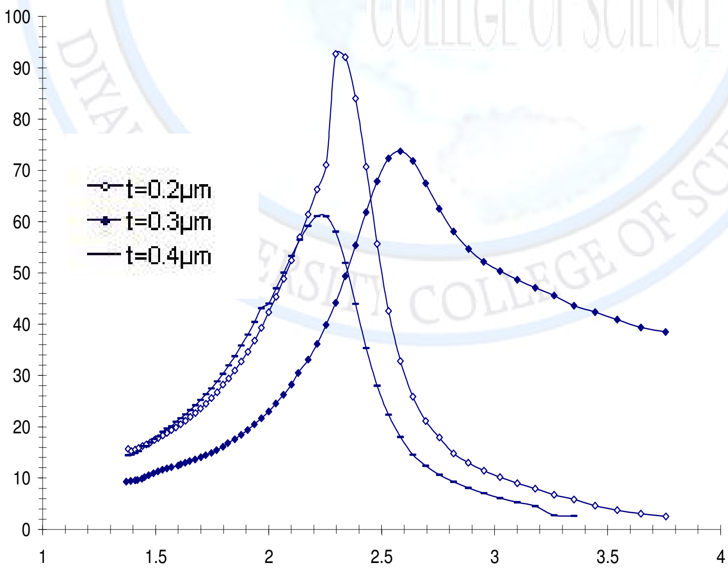
REFRECTIVE INDEX



PHOTON ENERGY

Figure (6) Refractive index with Photon energy

REAL PART OF DIELECTRIC CONSTANT



PHOTON ENERGY

Figure (7) Real part of dielectric constant

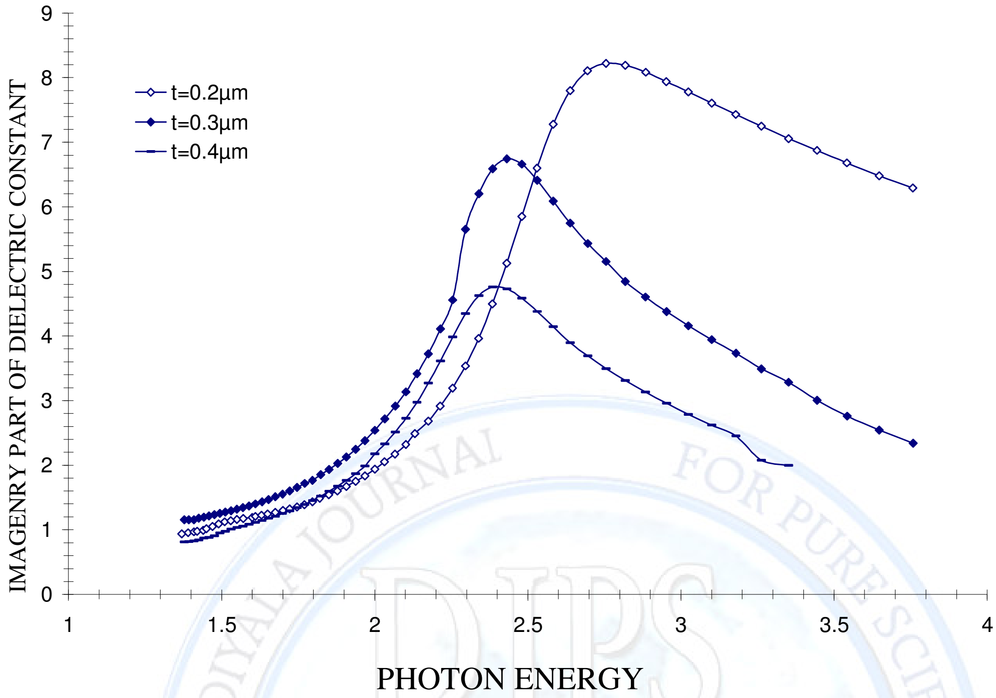


Fig.(8) Imagery part of dielectric constant