J.Thi-Qar Sci. Vol.4 (4) July/2014

ISSN 1991- 8690 الترقيم الدولي ١٩٩١ - ٨٦٩٠

website : http:// jsci.utq.edu.iq Email: utjsci@utq.edu.iq

# Optical properties of CdO films prepared by DC planar magnetron sputtering

Kadhim Abdulwahid Aadim* Hamid H.Murbet** Wassan Dhia Hussain**

* College of Science -University of Baghdad
** College of Science for Women -University of Baghdad

## Abstract

CdO films have been produced on glass substrates by DC planar magnetron sputtering technique in Ar and $O_2$ gases 1:4 and distance 6cm between cathode and anode and thickness 174 nm. It is observed from optical properties that the films possess transmittance 80% in visible and near infrared region of spectrum and direct band gap values in the rang 2.31-2.4 e V.

# الخصائص البصريه لاغشية اوكسيد الكلدميوم المحضره بتقنية الترذيذ المغناطيسي المستمر

كاظم عبد الواحد عادم* حامد حافظ مربط ** وسن ضياء حسين **

* كلية العلوم– جامعة بغداد

** كلية العلوم للبنات– جامعة بغداد

## الخلاصة

تم في هذا البحث دراسة وحساب بعض الخواص البصرية لأغشية أوكسيد الكادميوم المحضرة بتقنية الترذيذ المغناطيسي المستمر باستخدام غازي الاركون والاوكسجين بنسبة(١:٤) والمرسبة على قواعد الزجاج عندما كانت المسافة بين القطبين ٦ سنتمتر وسمك الغشاء كان ١٧٤ نانو متر.
لوحظ ان هذه الاغشية تمتلك نفاذية ٨٠% في منطقة الاشعه التحت الحمراء المرئية والقريبة من الطيف وان قيم فجوة الطاقة المباشرة تتغير من ٢,٣١ الكترون فولت الى ٢,٤ الكترون فولت.

## 1. Introduction

The use of transparent conducting oxides (TCO) in optoelectronic and photovoltaic devices has stimulated research on this field in recent years. In particular, cadmium oxide is a promising material for solar cell application [1–2], Various techniques have been employed to prepare CdO thin films such as spray pyrolysis [3], sputtering [4,5], solution growth [6], activated reactive evaporation [7], pulsed laser sputtering [8] and sol-gel method [9]. In this paper CdO thin film was prepared by DC planner magnetron sputtering technique. The three most essential parameters which decide the film properties prepared by the sputtering technique are the substrate temperature, deposition rate, and background pressure.
In this work, we prepared CdO films by DC planner magnetron sputtering and investigated the mutual dependence optical properties of the films as a function of wave length and effect annealing temperature of these films.

## 2. Experiments

To study of structural, optical properties we used corning glass slide substrates were cleaned by deionized water into ultrasonic vessel for 15 minutes, then same period in pure alcohol solution which reacts with contamination such as grease and some oxides. The slides eventually were dried by blowing air and wiped with soft paper. CdO was used as sputtering targets with diameter of 10 cm and thickness of 2 um was fixed at the top and down of the discharge chamber The CdO films were grown during (30) min onto glass microscope slides and Si were located diametrically on the top plate substrate holder. The base pressure in the chamber and the working pressure were 2.0 x 10-5mbar and 8 x 10-2 mbar, respectively. The dc power was 52 watt. The samples were prepared under constant conditions (pressure, substrate temperature, Substrate to target distance and rate of deposition); the main parameters that control the nature of the film properties with thickness of (174 nm) and annealing temperature (200).

## 3. Results and discussion

The optical transmittance spectra of the films were measured at RT and 473 k annealing temperature as show in (Fig. 1). It is clear that the film is transparent in the visible region and the optical transparency of the film decreases with increases in annealing temperature. This shows a shift of their transmission edges towards lower energies. Such type of shift is found in the films prepared by activated reactive evaporation method [10]. The shift towards higher or to lower energies depends on the method of film preparation [11]. The parallel transmission shift however indicates that it is related to changes in film structure [12]. The increase in transmittance with increasing of wavelength in UV region is not sharp. This indicates that the absorption band gap transitions in the studied films are due to direct and indirect transitions.

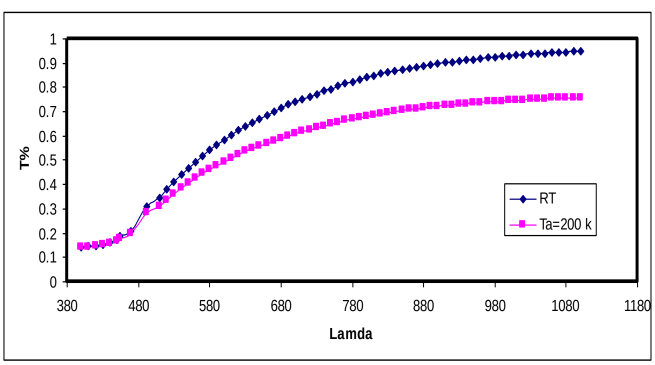



fig. (1) Transmission spectrum of CdO, at RT and 200 k annealing temperature.

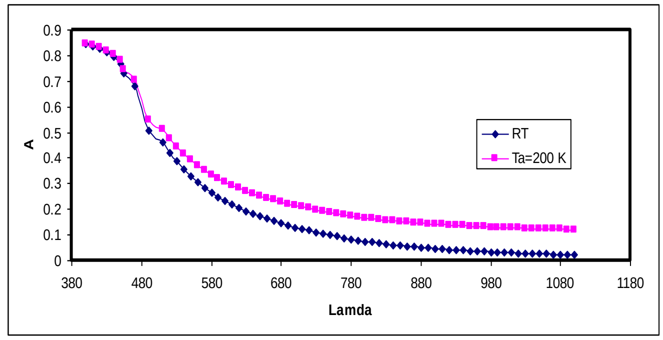



fig. (2) absorption of CdO films, at RT and 200 k annealing temperature.

The value of the optical band gap can be calculated using the fundamental absorption, which corresponds to electron excitation from the valance band to conduction band.

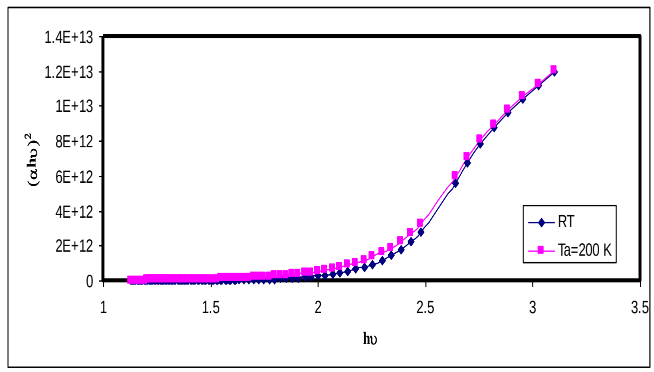
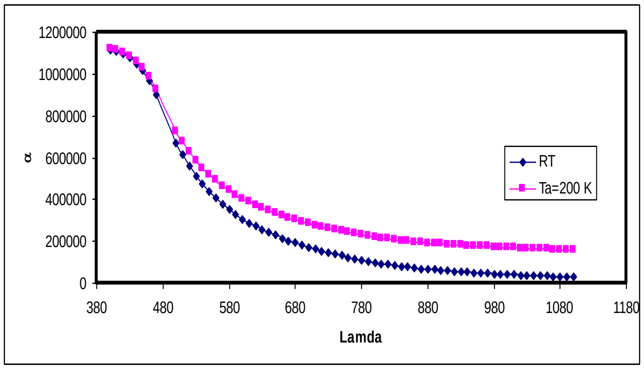



fig. (3). Energy gap of CdO films, at RT and 200 k annealing temperature.

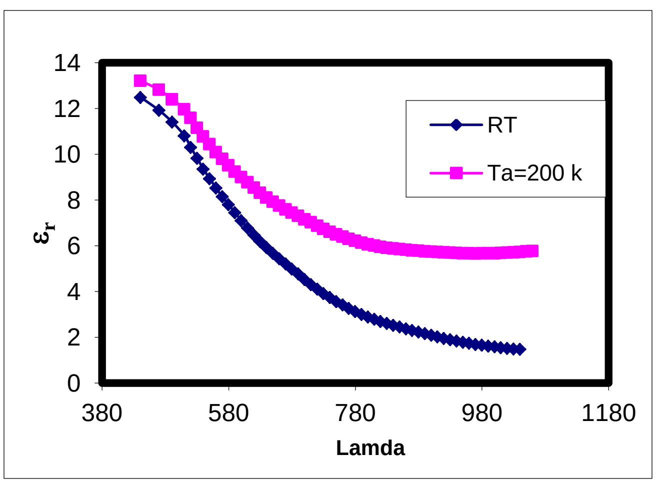
We have calculated the direct optical band gap from $(\alpha h\upsilon)^2$ versus h□ plot (Fig. 3) by extrapolating the linear portion of the graph to hυ axis. The intercept on the ht axis determines the direct band gap. The direct band gap value of the films varies between 2.31 and 2.4 eV (inset plot of Fig. 3). It can be found from Fig. 3 that the band gap value decreases with annealing temperature. This is in good agreement with the previously reported values of 2.4 eV and 2.42 eV [13,14]. This change in optical band gap is due to the decrease (or increase) of the Fermi energy in the degenerated semiconductor, and it is in agreement with the results of Vigi et al. [15], and has been attributed to local mechanical stress produced by impurities and defects [16].
The absorption coefficient (α) was determined from the optical transmission as a function of photon energy data

[17] as show in fig(4). absorption coefficient of the CdO films is characterized by strong absorption at shorter wavelengths region and without sharp edge on the long wavelength side from (400-1100) nm. In the shorter wavelength the absorption coefficient exhibits higher values within the range (1.1-1.12) 106 cm-1, these values of means that there is a large probability of the allowed direct transition and decreases with increases [18].

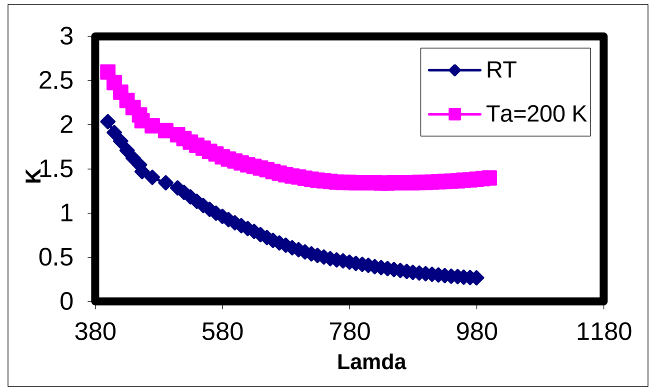



fig(4). The absorption coefficient (α) of CdO films .at RT and 200 k annealing temperature.

The extinction coefficient (ke), and the real (Ɛr) and imaginary (Ɛi) parts of the dielectric constant which have been estimated at λ e(400-1100). The obtained results show that the values of ke and εi are increased with increasing of Ta .

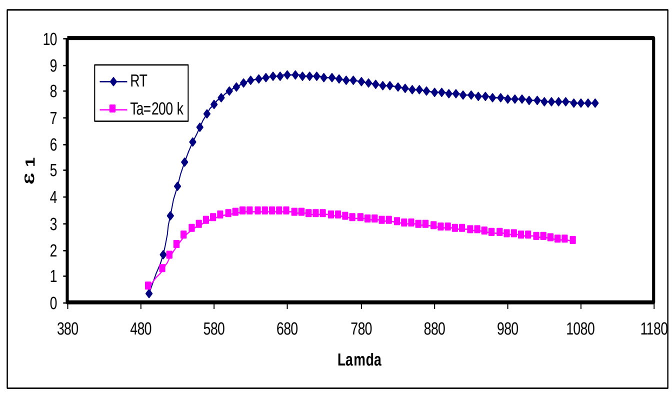



fig(5). The real dielectric constant $\varepsilon_r$ of CdO films .at RT and 200 k annealing temperature.




fig(6). The extinction coefficient (ke) of CdO films .at RT and 200 k annealing temperature.

This behavior may be due to increase in absorption coefficient and it is in agreement with results shown by Saha et al. [19], while El-Shazly and El-Shair [20] showed that ke is almost constant and it is independent of the substrate temperature.




fig(7). The imaginary dielectric constant $\varepsilon_i$ of CdO films .at RT and 200 k annealing temperature.

## 4 .Conclusions

In this work we have reported the influence of annealing in the optical characteristics of CdO thin films as a function of wave length. The optical transmittance measurement shows that the CdO film has a flat surface, a high average transmittance over 80% in the visible region and a direct band gap of 2.355 eV. The optical constants, absorption coefficient, extinction coefficient and optical dielectric constants, of these films were determined using transmittance and reflectance spectra.

## 5. References


[1] T.L. Chu, S.S. Chu, J. Elect. Mater. 19 (1990) 1003.

[2] A.A. Al-Qurani, C.H. Champness, in: Proceedings of the 26th IEEE Photovoltaic Specialists Conference, Anaheim, CA, 1997, p. 415.

[3] M. D. Uplane, P. N. Kshirsagan, B. J. Lokhande, C. H. Bhosale, Materials Chemistry and Physics **64**, 75 (2000).

[4] T. K. Subramanyam, S. Uthanna, B. Sinivasulu Naidu, Materials Letters 35(1998) 214, and Appl. Surface Science **169**, 529 (2001).

[5] K. Gurumurugan, D. Mangalaraj, Sa. K. Narayandass, J. Electron. Mater, **25**, 765 (1996).

[6] A. J. Varkey, A. F. Fort, Thin Solid Films **239**, 211 (1994).

[7] K. T. Ramakrishna Reddy, C. Sravani, R. W. Miles, J. Cryst. Growth **184/185**, 1031 (1998).

[8] I. I. Shagnov, B. P. Kryzhanovskii, V. M. Dubkov, Sov. J. Opt. Technol. **48**, 280 (1981).

[9] D. M. Carballeda-Galicia, R. Castanedo-Perez, O. Jimenez-Sandoval, S. Jimenez-Sandoval, G. Torres-Delgado, C. I. Zuniga-Romero, Thin Solid Films **371**, 105 (2000).

[10] K. T. Ramakrishna Reddy, C. Sravani, R. W. Miles, J. Cryst. Growth **184/185**, 1031 (1998).

[11] T. L. Chu, S. S. Chu, J. Electron Mater. **19**, 1003 (1990).

[12] J. P. De Neufville, S. C. Moss, and S. R. Ovshinsky, J. Non-Cryst. Solids **13**, 191 (1973).

[13] S. Weng and M. Concivera, J. Electrochem. Soc. 139, 3220 (1992).

[14] C. Sravani, K. T. R. Reddy and P. J. Reddy, Semicon. Sci. Technol. 6, 1036 (1991).

[15]O. Vigil, F. Cruz, A. Morales-Acevedo, G. Contreraspuente, L. Vaillant and G. Santana, Materials Chemistry and Physics 68, 249 (2001).

[16] J. L. Pankove, Phys. Rev. A 140, 2059 (1965).

[17] D.M. Carballeda-Galicia, R. Castanedo-Pe´rez, O. Jime´nez-Sandoval, S. Jime´nez-Sandoval, G. Torres-Delgado, C.I. Zu´n˜iga-Romero, Thin Solid Films 317 (2000) 105.

[18]. M. A. AL-Mengushi; "Study the Electronic Transport Mechanisms and Structural Properties of (Se90Te10-xPbx) Films"; A M.Sc. thesis University ofBaghdad; 2008.

[19] S. Saha, U. Pal, A. Chaudhuri, V. Rao and H. Banerjee, Phys. Stat. Sol. (a), V. 114 (1989) P.721.

[20] A. El-Shazly and H. El-Shair, Thin Solid Films, V.78 (1981) P.287.