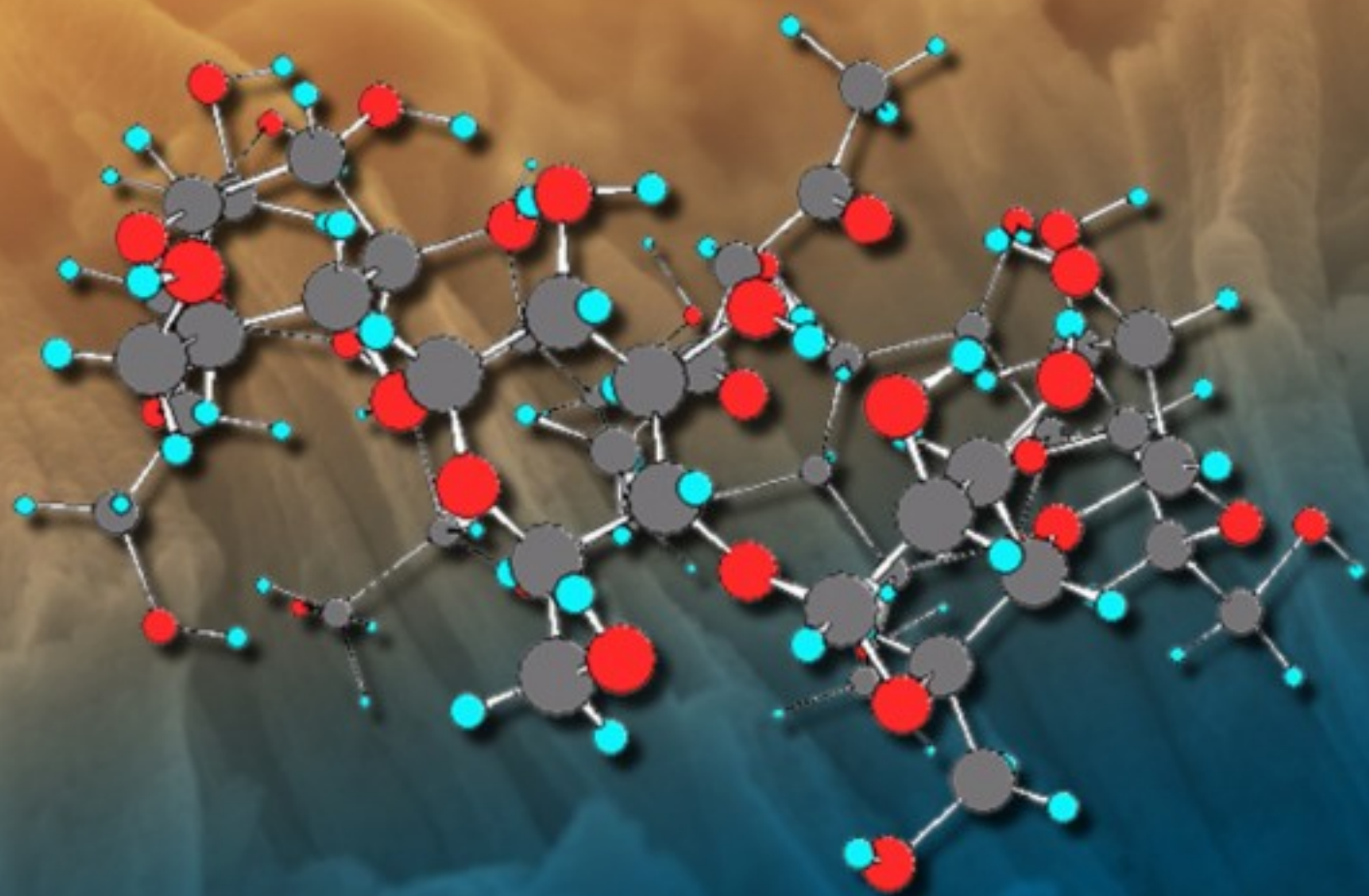


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Structural, Morphological and Optical Properties of Spray Deposited Nano-crystalline CdO Thin Films

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Abstract: Nanocrystalline, uniform, dense, and adherent cadmium oxide (CdO) thin films have been successfully deposited by a simple and cost effective spray pyrolysis technique. The effect of deposition temperature (250-350 °C) on structural, compositional, morphological, and optical properties of CdO thin films were studied by X-ray diffraction (XRD), Energy Dispersive Analysis by X-rays (EADX), Scanning Electron Microscopy (SEM), and UV-visible Spectroscopy (UV-vis). X-ray diffraction characterization of as-deposited CdO thin films reveals that films are of cubic structure with a (111) preferred orientation. The crystalline quality of the CdO films improves and the grain size increases with deposition temperature. These modifications influence the optical properties. The SEM images confirmed these results and showed larger grains and more crystallization for the higher deposition temperature. It has been determined that Cd and O elements are present in the solid film by using EADX. Increase in deposition temperature increased the optical transmission of the films substantially. The optical properties revealed the presence of direct band gaps with energies varied from 2.46 to 2.38 eV. *Copyright © 2012 IFSA.*

Keywords: Thin films, Semiconductors, X-ray techniques, Optical properties, EADX.

1. Introduction

In recent years, the metal oxide semiconductor materials have attracted much attention owing to their potential applications in electronic and photovoltaic devices. CdO is an important semiconductor with a rock-salt crystal structure (FCC) and possesses a direct band-gap of 2.2 eV [1]. Transparent

conducting oxide (TCO) thin films such as zinc oxide, indium oxide, tin oxide, indium tin oxide and cadmium oxide have attracted considerable attention because of their low resistivity and high optical transmittance [2-3]. Due to their optical and electrical properties, TCOs are used for photovoltaic solar cells, phototransistors, liquid crystal display(s), optical heaters, gas sensors, transparent electrodes and other optoelectronic devices [4-5]. Among these TCOs, cadmium oxide (CdO) is not a popular TCO material due to its low optical band gap. However, CdO is a particularly interesting material because it is one of the semiconducting oxides with high carrier mobility, and has great potential for using in optoelectronic devices [6]. Cadmium oxide (CdO) films have been prepared by different methods such as sol-gel [7], chemical bath deposition [8], spray pyrolysis [9], direct current magnetron sputtering [10] and radio-frequency sputtering [11].

2. Experimental Details

The CdO films were deposited on glass substrates by spray pyrolysis technique. In the preparation of CdO films 0.5 M cadmium sulphate was diluted with double distilled water. Aqueous solution of cadmium sulphate was prepared and sprayed through specially designed glass nozzle on to ultrasonically cleaned glass substrates. Spray rate 4 cc/min. was maintained constant by using air as a carrier gas. Substrate temperature of the heater was varied from 250 °C to 350 °C by using electronic temperature controller. The films prepared at different substrate temperature are denoted by C₂₅₀, C₃₀₀, C₃₅₀ etc. where subscript denotes the substrate temperature. X-ray diffraction, morphological and optical studies were carried out for all samples.

The crystal properties of the films were assessed by X-ray diffraction (XRD, Philips PW-3710 model) and the film composition and morphology was analyzed by scanning electron microscopy (JEOL JMS-6300 Electron Microprobe). The optical properties were analyzed from the film transmittance data, which were recorded using a UV-VIS Shimadzu 3101-PC spectrometer.

3. Results and Discussion

3.1. Structural Characterization

The X-ray diffraction patterns of as-deposited CdO film samples are shown in Fig. 1. It reveals that all the samples are polycrystalline, containing CdO phase. The crystallinity of the as-deposited samples is found to be increased as deposition temperature is increased. The diffractograms contain the characteristic CdO orientations along the direction (1 1 1). The presence of other peaks such as (2 0 0), (2 2 0), (3 1 1) and (2 2 2) has also been detected with relatively lower intensities. The matching of observed and standard d values [JCPDS card No PDF-75-0592.], confirms that the as-deposited films are of CdO with Cubic Face Centered structure. As deposition temperature increases, the crystallinity of the film increases due to homogeneous reaction occurring above surface of substrates. These results demonstrate that increase in deposition temperature is advantageous for crystallization of CdO thin films. The average X-ray particle size (D) can be determined using Scherrer's formula

$$D = \frac{k\lambda}{\beta \cos \theta}, \quad (1)$$

where the constant k is the shape factor ≈ 0.94 , λ is the wavelength of the X-rays (1.5406 Å for CuK α), θ is the Bragg's angle, and β is the full width at half maximum. The particle size increases with increasing deposition temperature and listed in Table 1.

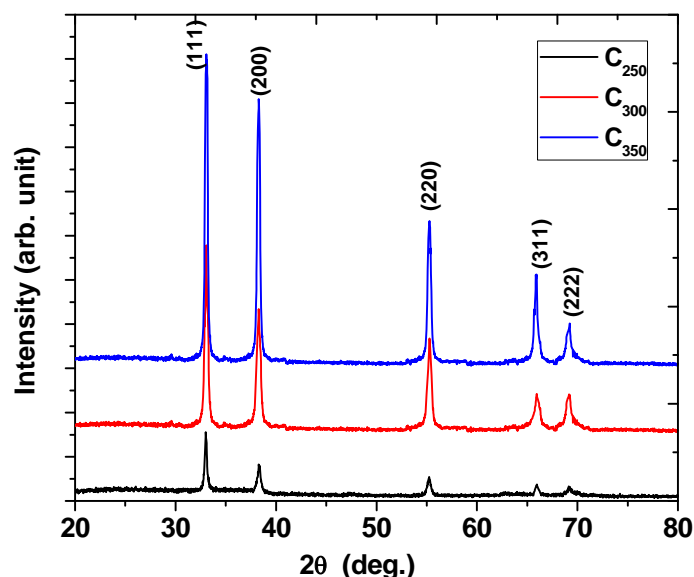


Fig. 1. XRD patterns of as deposited CdO thin films.

Table 1. Some physical parameters of CdO thin films deposited by spray pyrolysis.

Sample Code	Depo. Temp. ($^{\circ}$ C)	Thick. (nm)	Cryst. Size (nm)	Transmittance at 550 nm (%)	Band gap E_g (eV)
C ₂₅₀	250	310	22.6	69	2.46
C ₃₀₀	300	360	24.2	72	2.41
C ₃₅₀	350	395	25.8	80	2.38

3.2. Surface Morphology and Compositional Studies

It is known that the surface properties of the TCO films influence their optical and electrical properties which are important factors for applications in optoelectronic devices. Fig. 2 shows a typical SEM micrograph of CdO film deposited at 300 $^{\circ}$ C. It can be obviously seen from Fig. 2 that film has not a smooth and homogeneous surface morphology with a holes. But also, all the films are compact, dense and adhered well to the substrates. The surface properties of the CdO films appear to change significantly as a function of deposition temperature. EDAX spectra of the films were taken to see whether Cd and O elements in the starting solutions are present in the solid films or not. The EDAX spectra of CdO film is shown in inset of Fig. 2. These spectra show that the expected elements exist in the solid films.

3.3. Optical Characterization

In transparent metal oxides, metal to oxygen ration and crystal orientation decides the percentage of transmission. The information about physical properties, like band gap energy, band structure and optically active defects is determined from characterization of the films [12]. The optical transmittance of the film was studied in the wavelength range 300–900 nm. Fig. 3 shows the effect of substrate temperature on optical transmittance of as-deposited CdO thin films on amorphous glass substrates. It is observed that the film transparency depends on the growth temperature. The percentage transmittance at 550 nm wavelengths of the films grown at 250 $^{\circ}$ C, 300 $^{\circ}$ C and 350 $^{\circ}$ C are 69 %, 72 % and 80 % respectively. The effect of substrate temperature on optical band gap of CdO thin films has been determined from the data of transmittance vs. wavelength plot.

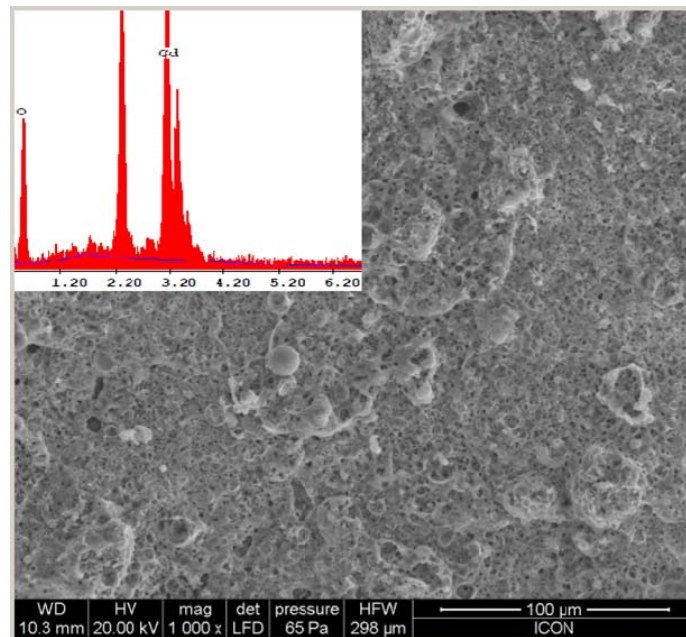


Fig. 2. Typical SEM image of CdO thin film at 300 °C and inset shows EDAX spectrum.

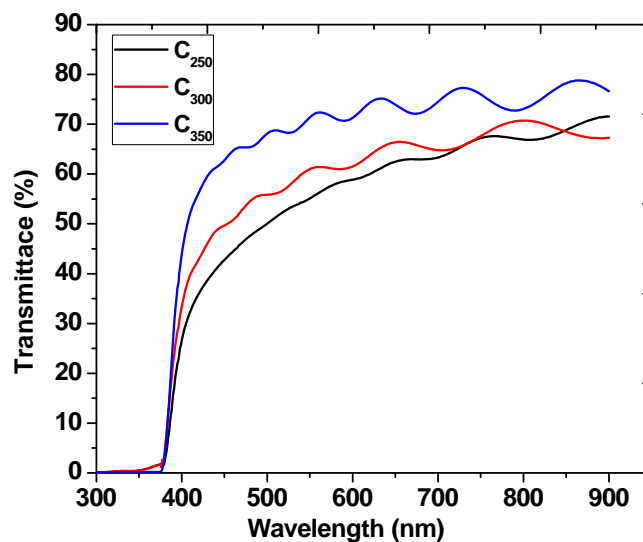


Fig. 3. Optical transmittance spectra of spray deposited CdO thin films.

The absorption coefficient is given by

$$\alpha = \frac{\ln(1/T)}{d}, \quad (1)$$

where T is the transmittance and d is the thickness of film. The film thickness of as-deposited CdO films is calculated by gravimetric weight difference method and listed in Table 1. The relation between absorption coefficient (α) and the incident photon energy ($h\nu$) is given by the following equation [13]:

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

where the symbols have their usual meanings. For allowed direct transition, $n = 1/2$. The value of absorption coefficient is found to be of the order of 10^4 cm^{-1} that supports the direct band gap nature of the semiconductor. The energy band gap (E_g) can be determined by extrapolating the linear regions of the plots to zero absorption. Fig. 4 shows the relationship $(\alpha h\nu)^2$ vs. $(h\nu)$ for films grown at different deposition temperature. The observed straight-line behavior establishes that the films have a direct band gap. The determined optical band gap values are listed in Table 1.

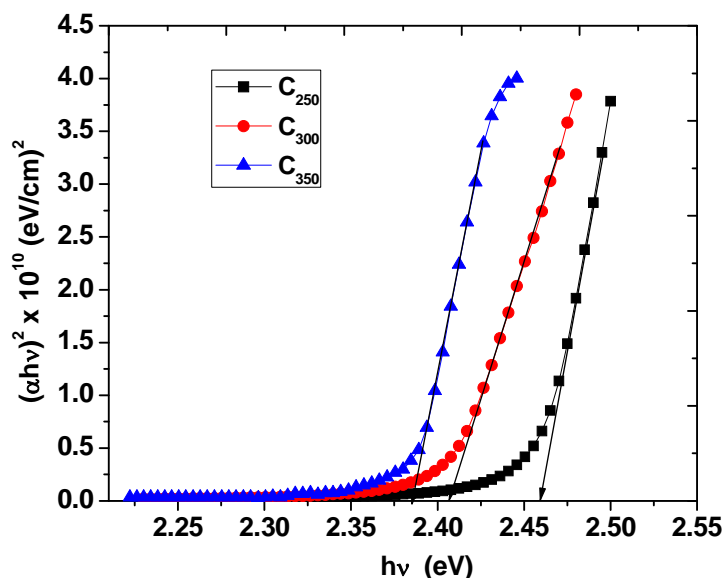


Fig. 4. Variation of $(\alpha h\nu)^2$ vs. $h\nu$ for CdO thin films.

4. Conclusions

Transparent and conducting CdO films were deposited on glass substrates at different substrate temperature by economical spray pyrolysis method. The effect of deposition temperature on structural, morphological and optical properties was studied. The polycrystalline CdO thin films were confirmed to be cubic crystal structure. The as-deposited CdO films exhibit good optical transmittance with decreased band gap values. This suggests that these films have significant commercial relevance.

References

- [1]. Dewei Ma, Zhizhen Ye, Lei Wang, Jingyun Huang, Binghui Zhao, Deposition and characteristics of CdO films with absolutely (200) preferred orientation, *Materials Letters*, 58, 1–2, January 2004, pp. 128-131.
- [2]. D. M. C. Galicia, R. Castanedo-Perez, O. Jimenez-Sandoval, S. Jimenez-Sandoval, G. Torres-Delgado, C. I. Zuniga-Romero, High transmittance CdO thin films obtained by the sol-gel method, *Thin Solid Films*, Volume 371, Issues 1–2, 2000, pp. 105-108.
- [3]. A. A. Dakhel, Physical Properties of Spray Deposited Mg Doped CdO Thin Films, *Semicond Sci Technol*, Vol. 21, 2009, pp. 579-585.
- [4]. M. Ocampo, A. M. Fernandez, P. J. Sebastian, Transparent conducting CdO films formed by chemical bath deposition, *Semicond. Sci. Technol.*, Vol. 8, 1993, pp. 750-755.
- [5]. A. A. Dakhel, Effect of cerium doping on the structural and optoelectrical properties of CdO nanocrystallite thin films, *Mater Chem Phys*, Vol. 130, Issues 1–2, 2011, pp. 398-402.
- [6]. R. Ferro, J. A. Rodriguez, O. Vigil, A. Morales-Acevedo, Contreras-Puente G., Highly transparent and conducting CdO films grown by chemical spray, *Phys Status Solidi, A*, Vol. 177, 2000, pp. 477-783.

- [7]. J. S. Cruz, G. T. Delgado, R. C. Perez, S. J. Sandoval, O. J. Sandoval, C. I. Z Romero, Dependence of electrical and optical properties of sol-gel prepared undoped cadmium oxide thin films on annealing, *Thin Solid Films*, Vol. 493, Issues 1–2, 2005, pp. 83-87.
- [8]. L. R. Gutierrez, J. J. C. Romero, J. M. P. Tapia, E. B. Calva, J. C. M. Flores, M. O. Lopez, Some physical properties of Sn-doped CdO thin films prepared by chemical bath deposition, *Materials Letters*, Vol. 60, Issues 29–30, 2006, pp. 3866-3870.
- [9]. B. J. Lokhande, P. S. Patil, M. D. Uplane, Studies on cadmium oxide sprayed thin films deposited through non aqueous medium, *Mater Chem Phys.*, 2004, 84, p. 238-242.
- [10]. T. K. Subramanyam, S. Uthanna, B. S. Naidu, Preparation and characterization of CdO films deposited by dc magnetron reactive sputtering, *Mater Lett.*, Vol. 35, Issues 3–4, 1998, pp. 214-220.
- [11]. Ueda N, Maeda H, Hosono H, Kawazoe H, Observation of carrier dynamics in CdO thin films by excitation, *J Appl Phys.*, Vol. 84, 1998, pp. 6174-6179.
- [12]. A. V. Mohalkar, G. L. Agawane, U. S. Kyu, K. Ye-bin, K. Y. Rajpure, J. H. Kim, Influence of deposition temperature on morphological, optical, electrical and opto-electrical properties of highly textured nano-crystalline spray deposited CdO:Ga thin films, *Appl. Surf. Sci.*, Vol. 257, Issue 1, 15, 2010, pp. 93-101.
- [13]. H. Fujiwara, Spectroscopic Ellipsometry Principles and Applications, *John Wiley & Sons Ltd*, England, 2007.

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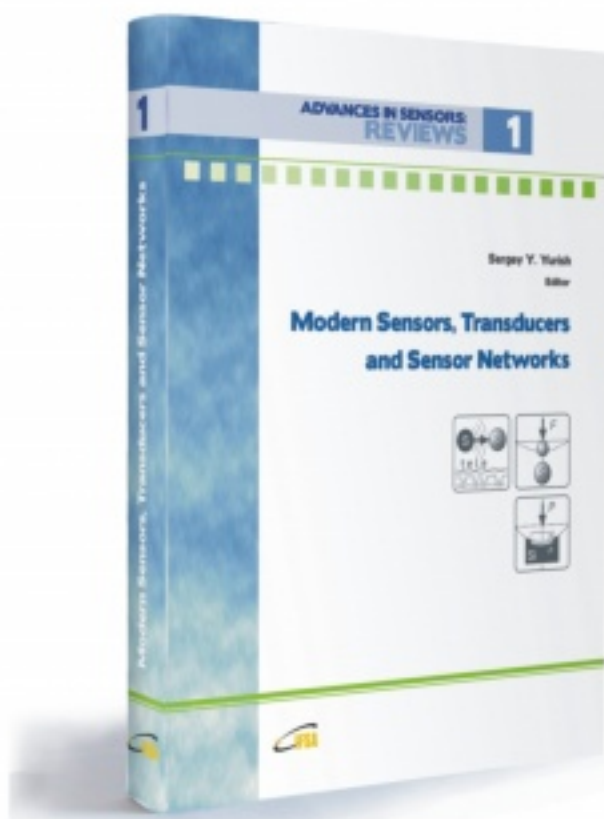
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