Research paper

Optical characteristics of CdO nanostructure

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ABSTRACT

The Cadmium Oxide (CdO) semiconducting transparent nanostructure film is deposited on glass substrates by spray pyrolysis. The structural and optical properties of the grown films are presented. The crystalline structure was studied by X-ray diffraction. The direct band gap of CdO nanofilm was found to be 3.4eV, comparing with that of the bulk CdO.
Keywords: CdO nanostructure, Spray pyrolsis, XRD, Optical properties.

1. INTRODUCTION

During the last years researchers have focused on one-dimensional semiconductor nanomaterials due to their unique properties, among these materials, CdO is n-type semiconductor with a ranging direct band gap 2.2-2.7 eV and an indirect band gap of 1.98(Guillermo et al.,2000, S. ILICAN.et al. 2009, Wenting et al.2003, S.Aksoy et al.2011, V. Eskizeybek et al.2011). CdO has many attractive properties such large energy bandgap, high transmission coefficient in visible spectral domain, remarkable luminescence characteristics etc.

This materials have been widely studied for optoelectronic applications in transparent conducting oxides (TCO) (Zhiyong et al.2002), solar cells(A.M.Baranov et al.2000), photovoltaic device(C.H.Champness et al.1985),photodiodes(R.Kondo et al.1971) as well as other types of applications like IR heat mirror, gas sensors(R.L. Mishra et al.2009), low-emissive windows, thin-film resistors, etc (Gomez et al.2001,Yan et al.2001).

A Variety of techniques have been used employed to prepare CdO nanostructure such as spray pyrolysis(Peter et al.2004,Osvaldo et al.2001), chemical vapour deposition(Hani et al.2011), sol-gel method(S.Sakthivel et al.2011) and DC magnetron sputtering (T.K. et al.2001).

In this work spray pyrolysis technique used to prepare CdO nanostructure, the structural and optical properties of the films have been studied.

2. EXPERIMENTAL WORK

The CdO nanofilms were prepared by chemical spray pyrolysis technique. The films were deposited on glass substrate heated to (250ºC). A 0.1M Spray solution is prepared by dissolving cadmium acetate ($Cd(CH_3\ COO)_2.2H_2O$) of molecular weight equal to 266.527gm / mole in a mixture of methanol and deionized water (1:1).The above mixture solution was placed in the flask of the atomizer and spread by controllable pressurized nitrogen gas flow on the heated substrates. The spraying time was 4 seconds, which is controlled by adjustable solenoid valve. The heated substrate was left for 12 sec after each spraying run to give time for the deposited (CdO) layer to be dry. The optimum experimental conditions for obtaining

homogeneous CdO thin film at (250 ºC) were determined by the spraying time, the drying time and the flashing gas pressure.

The thickness of the prepared films was measured by laser interferometer technique. The thickness of the films was found to be in the range between (800-1000μm).

3. RESULT AND DISCUSSION

3.1 STRUCTURAL CHARACTERISTCS

The X-ray diffraction (XRD) pattern of the CdO nanofilm deposited on glass substrate is illustrated in Figure 1.

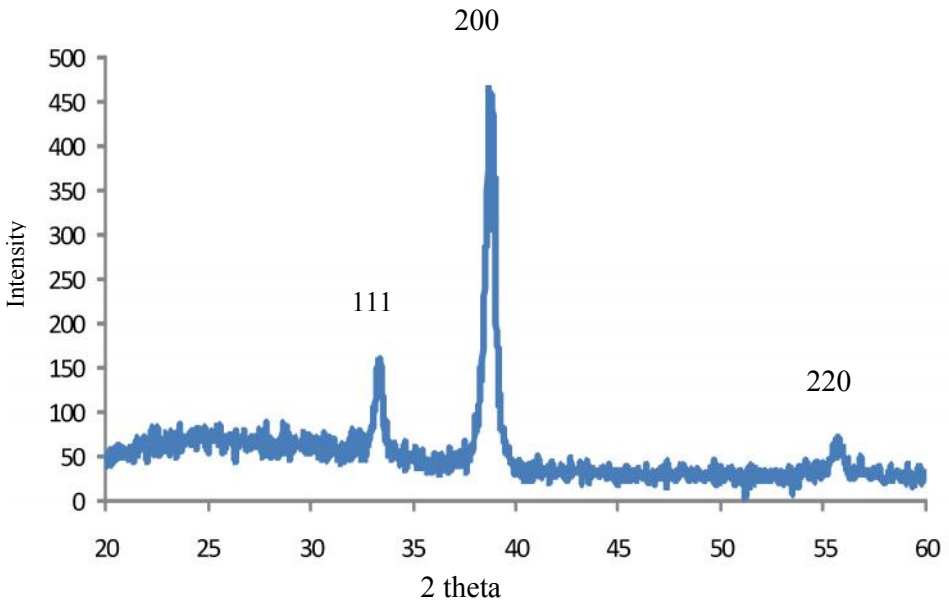

Fig. 1. XRD of CdO nanofilm**.**

The figure shows the (111), (200), and (220) peaks occurred at 2Θ values of 33° , 38° and 55.2° respectively, with full width at half maximum (FWHM) of (200) peak of about 0.658°. The CdO nanofilm are strongly crystallized with a preferred (200) orientation, which has been observed by other authors (V.Eskizeybek et al.2011,Osvaldo et al.2001,A.R et al.2012) Particle size was determined from the width of XRD peaks using Scherer's formula (C.Oprea et al.2008):

$$D = \frac{K\lambda}{\beta \cos \theta} \quad \text{..... .....} \quad \text{.....} \quad 1$$

Where D is the grain size, K is the shape factor, being equal to 0.9, λ is the wavelength of X-ray, β is the full-width at half maximum FWHM (degree), and θ is

the diffraction angle in degree. Figure 1 shows the grain size of CdO sample (24.4nm) obtained from the FWHM of peak corresponding to $2\Theta=38.60^{o}$.

3.2 OPTICAL PROPERTIES

The transmission spectrum of the CdO films deposited on glass substrate is shown in Figure 2and 3. Figure 2, shows the optical transmission spectrum of CdO nanofilm, the film shows high transmission in visible and IR region and low transmission in UV region.

Figure 3, shows the absorpance spectrum of CdO nanofilm, the figure shows high absorption coefficient in the UV region, whereas it is transparent in the visible region. Assuming direct transition, the dependence of $(\alpha h\upsilon)^2$ on the photon energy $h\upsilon$ is plotted following Taue relation (J.I et al.1971) and the graph is illustrated in Figure.4.

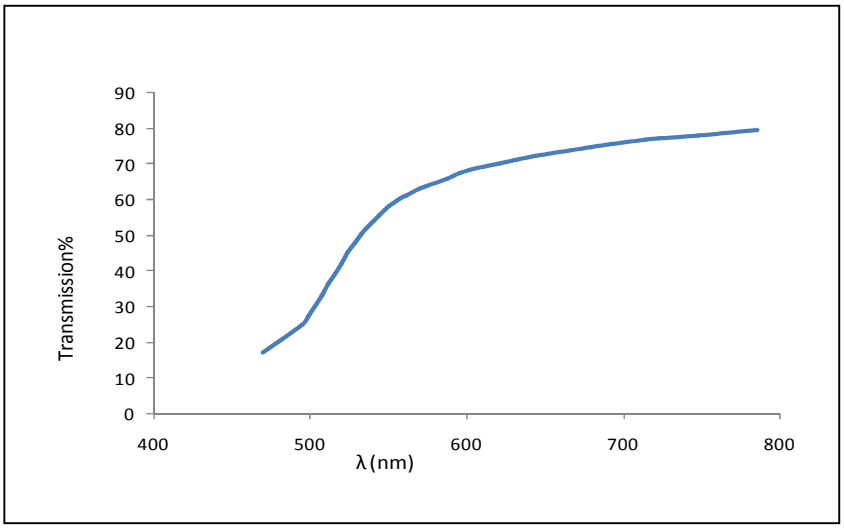

Fig. 2. The transmission spectrum of CdO film on glass substrate.

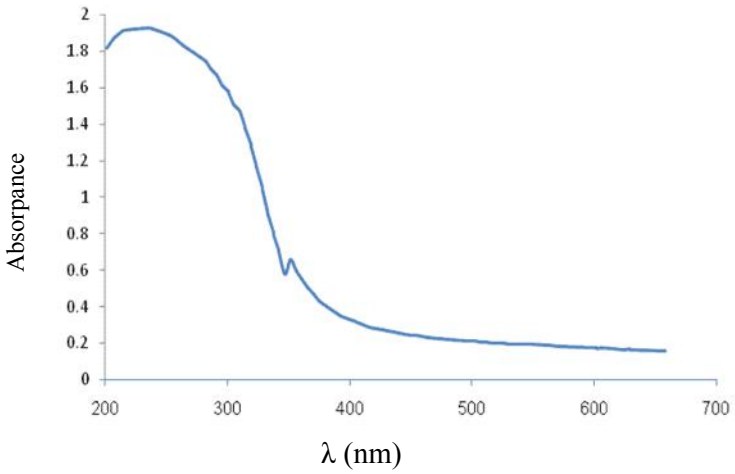

Fig. 3. The absorpance spectrum of CdO nanofilm deposite on glass substrate.

The extrapolation of the linear part of the above plot to $(\alpha h\upsilon)^2 = 0$ give the energy gap value of the CdO nanofilm , which was found to be about 2.5eV and 3.46 eV. The above two value may be related to the nanostructured CdO film and to bulk CdO material. This value is in a good agreement with the values presented by other workers (Wenting et al.2003, K. Manickathai et al.2008).

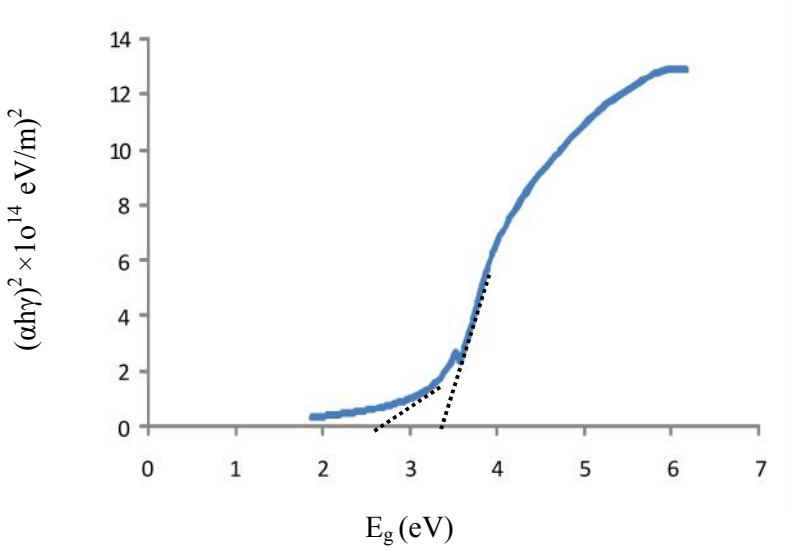

Fig.4. Energy gap determination of CdO nanofilm.

The photoluminescence spectrum of CdO nanofilm on glass substrate is plotted using SL 174 spectrofluorometer supplied by ELICO Company covering the 300–900 nm wavelength range .The room temperature photoluminescence spectrum of CdO film deposited on glass substrate excited by 300nm line is shown in Figure 5.

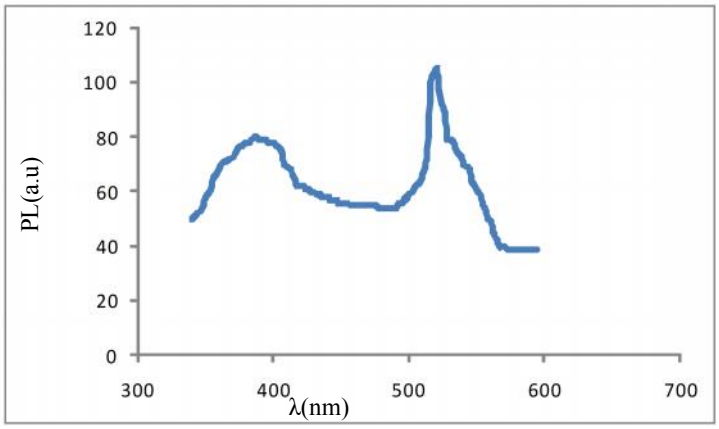

Fig. 5. The Photoluminescence spectrum of CdO nanofilm on glass substrate

The spectrum shows two peaks: the first peak at 386 nm which can be referred to the strong direct band transition (or band to band transition). The second peak at 520nm is due to the exciton emission.

The energy band gap from photoluminescence spectrum of the CdO film is calculated by using the following equation

$$E_g = \frac{1240}{\lambda(nm)} \text{..... ....} 2$$

For the PL wavelength 386nm and 520nm the energy band gap found are to be (3.2 and 2.38eV). Similar peaks in spectrum of CdO have been reported by (Amrut et al.2011).

4. CONCLUSIONS

In this work CdO nanofilms were deposited on glass substrates by Spray pyrolysis technique. The X-ray diffraction indicated that the film was of polycrystalline structure. The optical absorption and transmission has been studied.

The direct energy gap of CdO nanofilms were found to be (3.46eV) comparing with that of the bulk CdO. The grain size of the deposited nanofilms is determined to be 24.4nm.

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