Optical characteristics of CdO nanostructure

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ABSTRACT

The Cadmium Oxide (CdO) transparent nanostructure semiconducting film is deposited on glass substrates by spray pyrolysis method at 250C°. The structural and optical properties of the growth 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 the 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[1-5]. 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)[6], solar cells[7], photovoltaic device[8],photodiodes[9] as well as other types of applications like IR heat mirror, gas sensors[10], low-emissive windows, thin-film resistors, etc [11-12].

A Variety of techniques have been used employed to prepare CdO nanostructure such as spray pyrolysis[13-14], chemical vapour deposition[15], sol-gel method[16] and DC magnetron sputtering [17].

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, and 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 nanofilms at (250 ºC) were determined by the spraying time, the drying time and the flashing gas pressure.

The thickness of the prepared nanofilms was measured by laser interferometer technique. The thickness of the nanofilms was found to be in the range between (500-700μm).

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3. RESULT AND DISCUSSION

3.1 STRUCTURAL CHARACTERISTCS

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

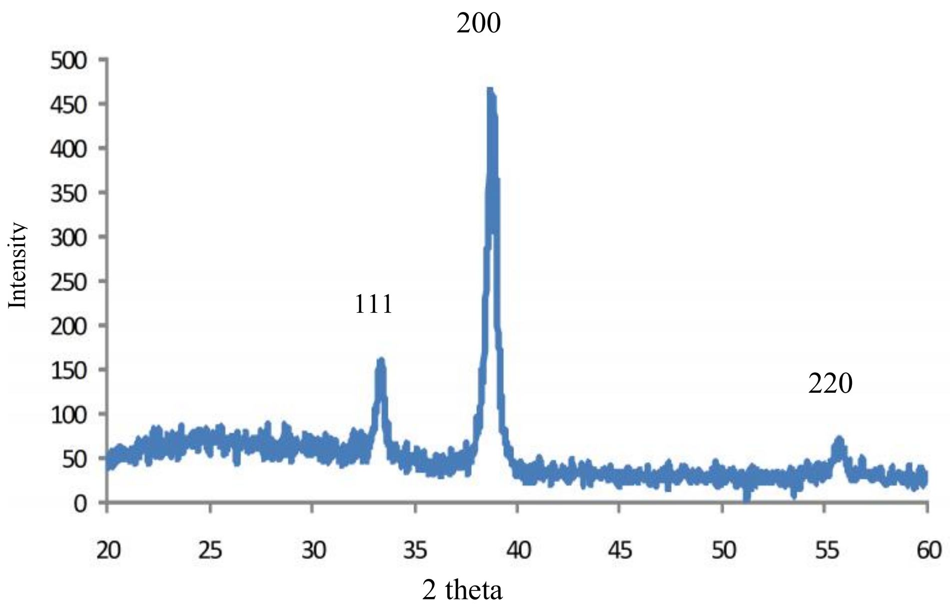

Fig. 1. XRD of CdO nanofilm.

Figure1. shows that the peaks occurred at 2Θ values of 33°, 38° and 55.2° respectively,which respect to (111), (200), and (220) Miller indices, the full width at half maximum (FWHM) of (200) plane of about 0.658°. The CdO nanofilm are strongly crystallized with a preferred (200) orientation, which has been observed by other authors [5,14, 18] ,the particle size was determined from the width of XRD peaks using Scherer's formula [19].:

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

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, the calculated grain size of CdO sample was (24.4nm) obtained from the FWHM of peak corresponding to 2Θ=38.60°.

3.2 OPTICAL PROPERTIES

The transmission spectrum of the CdO film that deposited on glass substrate was shown in Figure 2. The film shows high transmission in visible and IR region and low transmission in UV region.

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Figure 3, shows the absorpance spectrum of CdO nanofilm, the figure shows high absorption coefficient in the UV region, whereas it's transparent in the visible region. Since CdO had direct transition, the dependence of $(\alpha h\upsilon)^2$ on the photon energy $h\upsilon$ is plotted following Taue relation [20] that which illustrated in Figure.4.

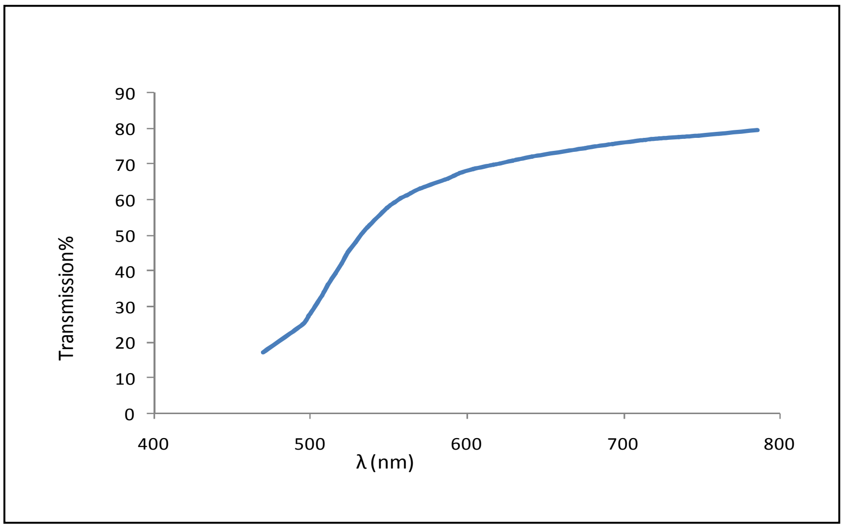

Fig. 2. The transmission spectrum of CdO nanofilm on glass substrate.

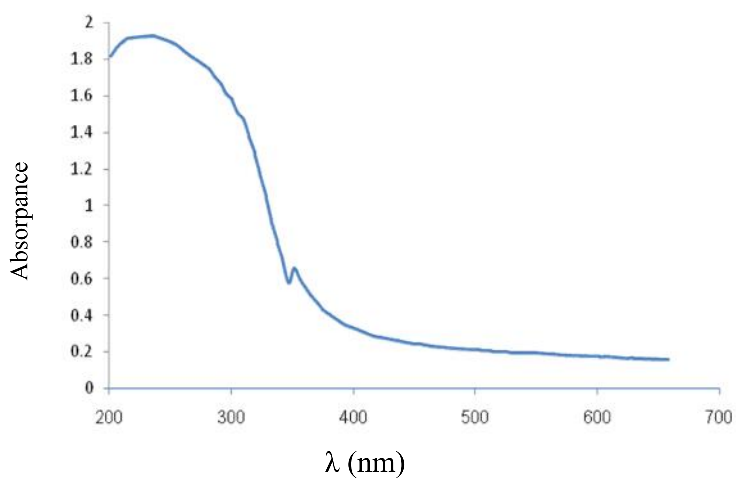

Fig. 3. The absorpance spectrum of CdO nanofilm deposite on glass substrate.

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The extrapolation of the linear part of the above plot to (αhυ $)^2 = 0$ give the energy gap value of the CdO nanofilm , which was found to be about 2.5eV and 3.46 eV. These two values may be related to the nanostructured CdO film and to bulk CdO material. These values show a good agreement with the values published by other workers [3,21].

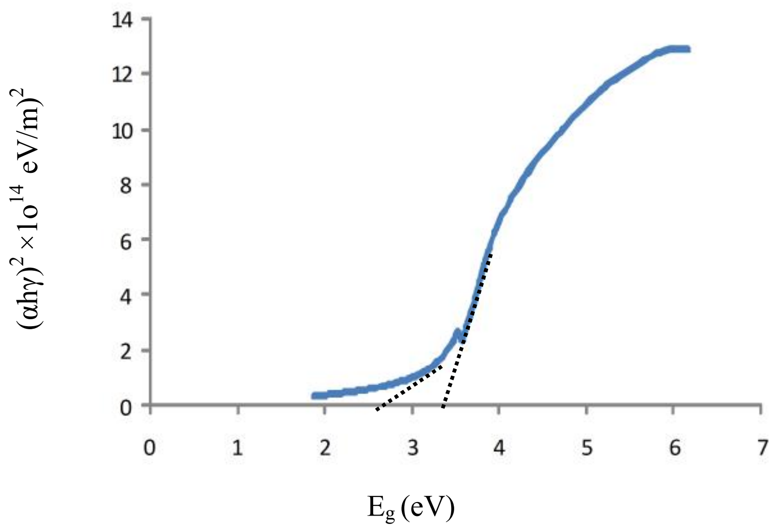

Fig.4. variation of $(\alpha h\upsilon)^2$ versus photon energy for CdO nanofilm.

The photoluminescence (PL) spectrum of CdO nanofilm that deposited on glass substrate was 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.

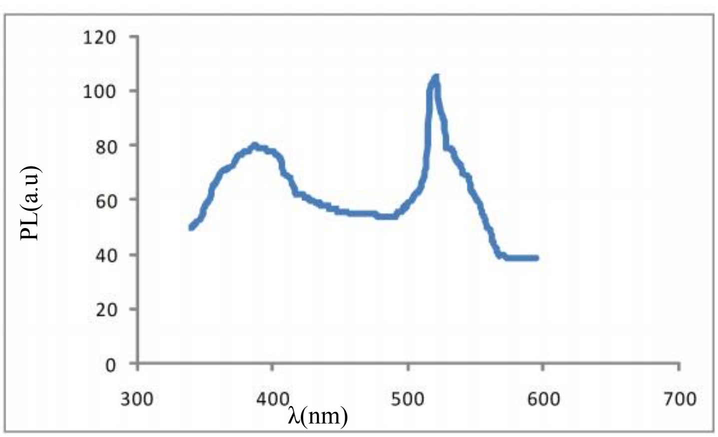

Fig. 5. The Photoluminescence spectrum of CdO nanofilm on glass substrate

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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 can be determine from the photoluminescence spectrum of the CdO nanofilm is calculated by using the following equation

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

For the PL spectrum wavelengths 386nm and 520nm the energy band gap are found to be (3.2 and 2.38eV). Similar peaks in PL spectrum of CdO have been reported by [22] .

4. CONCLUSIONS

In this work the CdO nanofilms that deposited on glass substrates is prepared by Spray pyrolysis technique. The X-ray diffraction indicated that the film was of polycrystalline structure. 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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