International Journal of Researches in Biosciences, Agriculture & Technology | January 2014 Issue-2, Volume-1 | ISSN No. (Online) 2347-517X

STRUCTURAL AND OPTICAL PROPERTIES OF CdO THIN FILMS DEPOSITED BY SPRAY PYROLYSIS TECHNIQUE.

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Abstract:-

Cadmium Oxide [CdO]films were deposited on glass Substrate by Spray Pyrolysis. Transparent and Conducting CdO films prepared at 300°C temperature. The optical band gap of the CdO films deposited at 300°C was estimated and found to vary from 2.24eV- 2.49eV . X-ray diffraction (XRD) studies indicate the formation of polycrystalline cubic CdO phase. Scanning Electron Microscopy (SEM) shows that the films prepared at 300°C consists of spherical shape grains with size in nanometer range. UV-VIS spectrum of the films showed that the optical band energy increases with concentration of Cadmium Chloride in the solution.

Keywords: CdO thin films, XRD, SEM, Band gap, Structural, Optical properties.

Introduction:-

Transparent conductive oxides (TCOs), an attracting type of Semiconducting materials that are both optically transparent and electrical conductive, have potential application in Optoelectronic devices such as solar cells, photovoltaic, flat panel displays, transparent electrodes, Ohmic contact to LEDs, and heat reflectors [1-4]. In recent years CdO- based TCOs (binary semiconducting Oxides, received much attention due to their exceptional carrier mobility, nearly metallic conductivities and simple crystal structure [5]. Many techniques were adopted to glow CdO films such as : thermal evaporation [6], metal vapaur organic deposition [7], Spray Pyrolysis [5], rapid photothermal oxidation of cd [8] and pulsed laser deposition [9-10].

During the last few years thin films of Cadmium Oxide (CdO) has revealed itself as a very promising material for use in photovoltaic industry. Because of its high electrical conductivity, high optical transparency in the spectral region of sun radiation[11].

CdO has a direct optical energy bandgap of 2.45ev and the electrical properties can suitably controlled by altering the deposition conditions[12].

CdO belongs to the family of transparent conducting Oxide films whose extremely wide range of physical and chemical properties makes them important materials both for technological and industrial applications[13].

Spray Pyrolysis technique (Chopra et at 1982) has been used for several decades in glass industry and in solar cell production to deposit electrically conducting electrodes. Thin films formation using this techniques involves spraying a metal salt solution onto a heated substrate. The sprayed droplet reacting the hot substrate surface undergoes pyrolytic decomposition and forms the desired product[14].

Experimental:

Spray Pyrolysis is basically a chemical process involves spraying aqueous solution onto a substrate held at high temperature, where the substrate provides the thermal energy for the thermal decomposition and subsequent recombination of the constitutent species followed by sintering and recrystallization of the clusters of crystallite giving rise to a coherent films. A simply glass nozzle was fabricated to give a fine and very small droplets of solution which is driven by air from the compressor. The solution was prepared by dissolving a known quantity of Cadmium Chloride in deionised water[13].

Cadmium Oxide thin films have been deposited on glass substrate from aqueous solution of Cadmium Chloride CdCl2. In concentration range from 0.01 M, 0.025M & 0.05M using Spray Pyrolysis technique[14].

The crystalline structures and the surface morphologies of the deposited films were investigated by using X-ray diffraction (XRD) and scanning electro microscopy (SEM). The optical transmission and the absorption for the sample were measured with a UV-VIS spectrophotometer[15].

Result and Discussion

Structural Properties:-

The X-ray diffraction (XRD) pattern of the CdO thin films was shown in the fig.1 The presence of Several peaks in the XRD pattern reveals that the films are polycrystalline. The structure was found to be cubic.

The average grain Size (g) of the polycrystalline material can be calculated from the X-ray spectrum by means of full width at half maximum (FWHM) method (Scherrer relation) [13]:

$$g = \frac{0.94\lambda}{[\Delta_{(2\theta)} COS\theta]} \dots\dots\dots\dots (1)$$

Where,

λ: is the X-ray wavelenghth (A°)

$\Delta_{(2\theta)}$: FWHM (radian)

θ : Bragg diffraction angle of the XRD peaks (degree)

Where $\Delta\theta$ is the full width at half maximum of the XRD peaks appearing at the diffraction angle θ, A represents the shape factor.The grain size (g) was found to be 315 nm & 352nm.

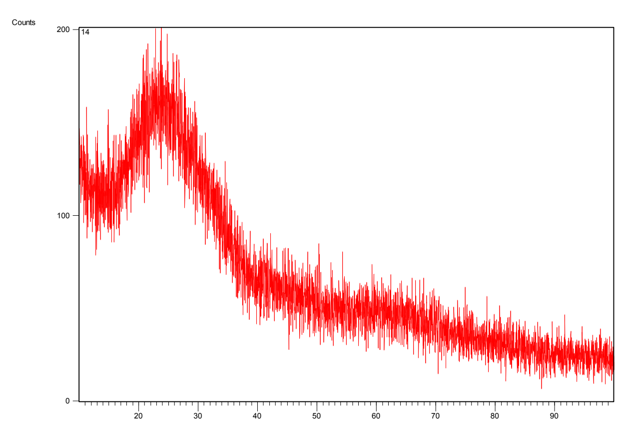


Fig 1 X-ray diffraction pattern of sprayed CdO film at substrate temperature, 300^{0}C

Fig 2 Scanning Electron microscopy as deposited
CdO on glass substrate at, 300^0C sprayed

Optical Properties : The Optical absorption in the UV region is dominated by the optical band gap of the semiconductor. The optical band gap (Eg) of a semiconductor is related to the optical absorption coefficient (α) and the incident Photon energy (hυ) by [12, 13]

$$(\alpha h\upsilon) = (Eg - h\upsilon)^n, \text{ .... } (1)$$

Where n depends on the kind of optical transition that prevails specifically, n is1/2and 2 when the transition is directly and indirectly allowed, respectively. The CdO films are known to be a semiconductor with a directly allowed transition, and its optical band gap can be obtained by plotting the optical absorption verses the photon energy and extrapolating the linear portion of the curve to $(\alpha h\upsilon)^2 = 0$. The optical band gap of the CdO films prepared at a substrate temperature 300^oC was 2.24eV, 2.35eV & 2.49eV as shown in fig 7a, 7b & 7c. This is in good agreement with the previously reported values of 2.4 ev and 2.42 eV [14,15].

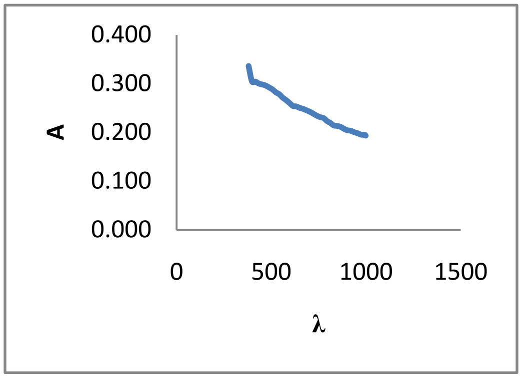


Fig :3a The absorption spectra of CdO thin Film as a function to wavelength thickness, t= 0.4170 µm

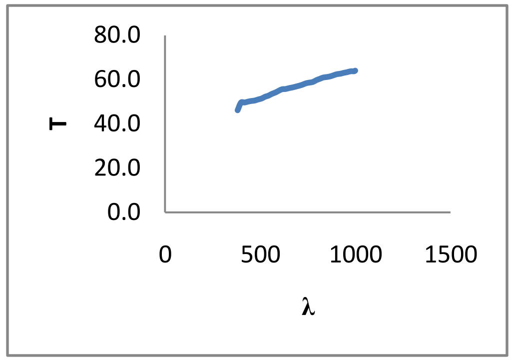


Fig :4a The transmission spectra of CdO thin Film as a function to wavelength thickness, t= 0.4170 µm

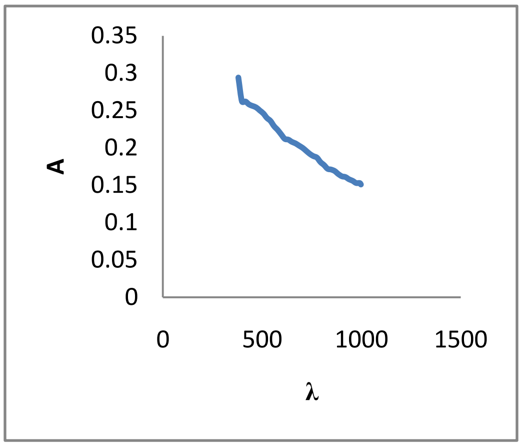


Fig: 3b The absorption spectra of CdO thin Film as a function to wavelength thickness, t= 0.4391 µm

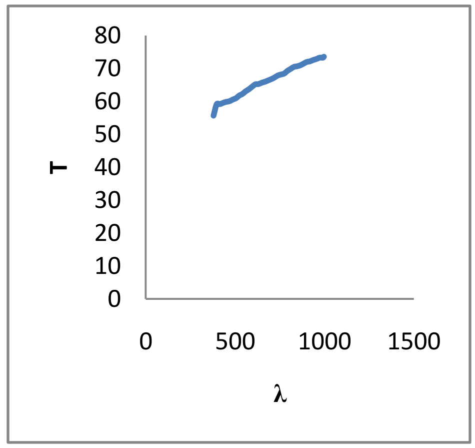


Fig: 4b The transmission spectra of CdO thin Film as a function to wavelength thickness, t= 0.4391 µm

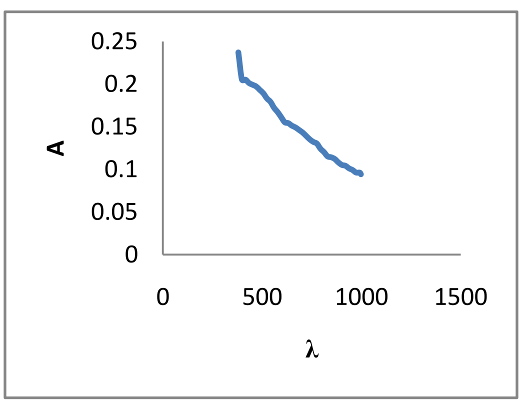


Fig: 3c The absorption spectra of CdO thin Film as a function to wavelength thickness, t= 0.5248 µm

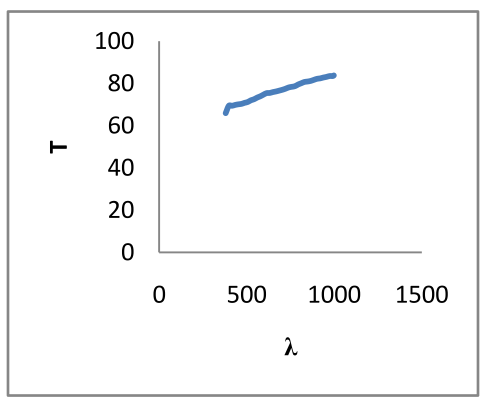


Fig: 4c The transmission spectra of CdO thin Film as a function to wavelength thickness, t= 0.5248 µm

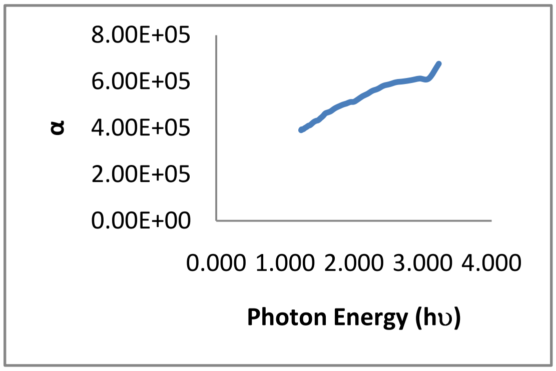


Fig:5a The absorption Coefficient of CdO thin Film as a function to photon energy, thickness, t= 0.4170 μm

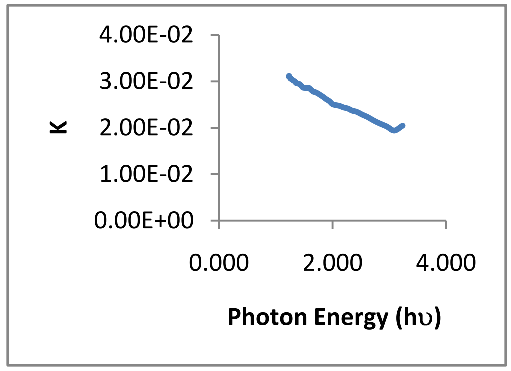


Fig:6a The extinction Coefficient of CdO thin Film as a function to photon energy, thickness, t= 0.4170 μm

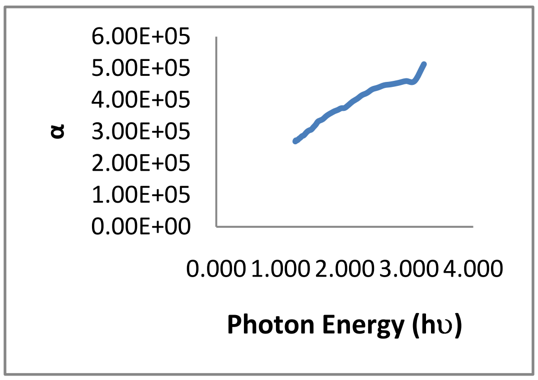


Fig: 5b The absorption Coefficient of CdO thin Film as a function to photon energy, thickness, t= 0.4391 μm

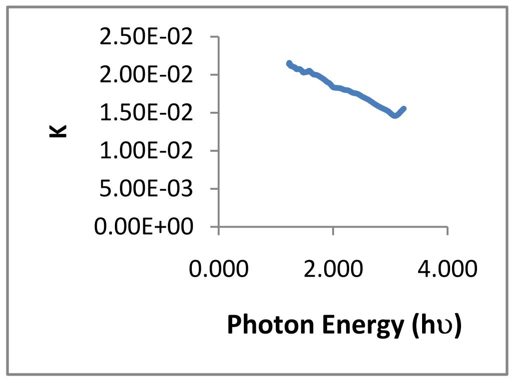


Fig:6b The extinction Coefficient of CdO thin Film as a function to photon energy, thickness, t= 0.4391 μm

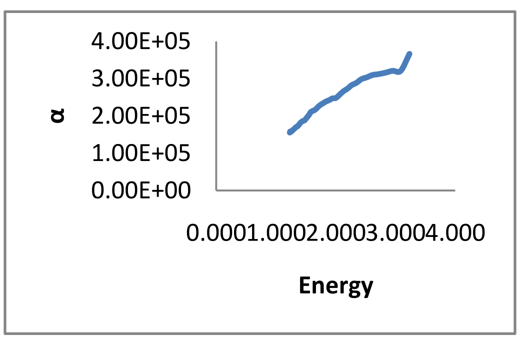


Fig: 5cThe absorption Coefficient of CdO thin Film as a function to photon energy, thickness, t= 0.5248 μm

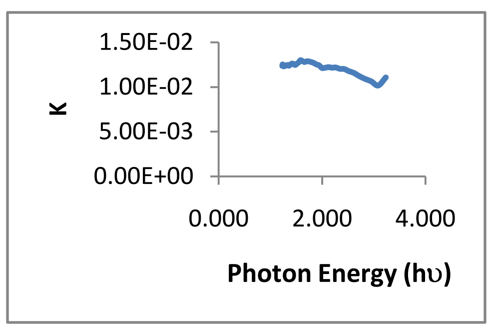
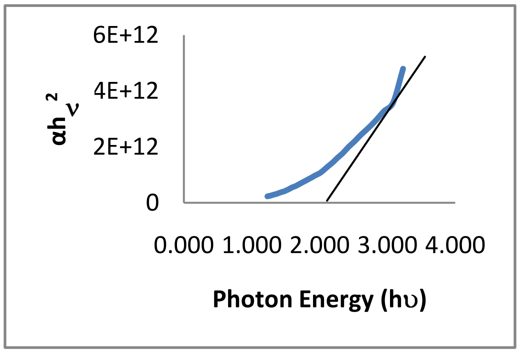


Fig:6c The extinction Coefficient of CdO thin Film as a function to photon energy, thickness, t= 0.5248 μm

International Journal of Researches in Biosciences, Agriculture & Technology | January 2014 Issue-2, Volume-1 | ISSN No. (Online) 2347-517X



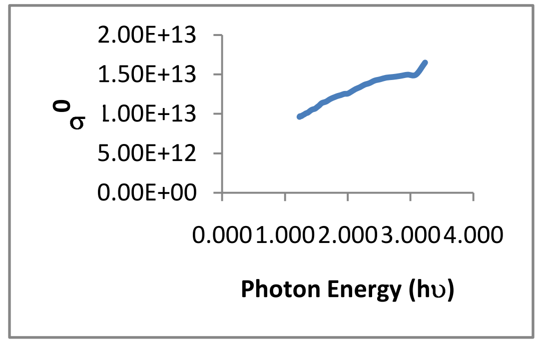
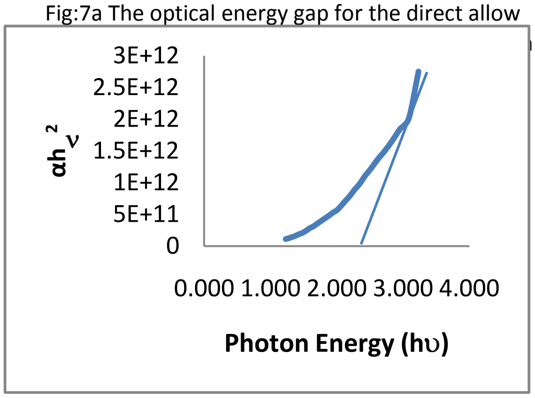


Fig: 8a The optical conductivity of CdO thin Film as a function to the photon energy, thickness, t= 0.4170 μm

Fig:7a The optical energy gap for the direct allow



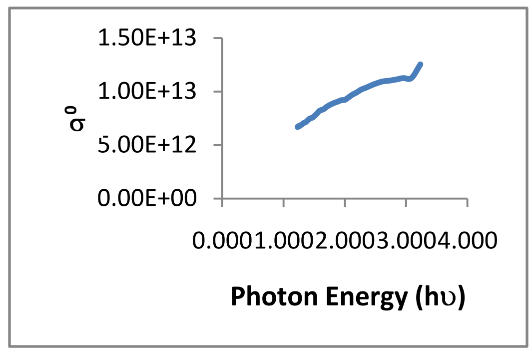
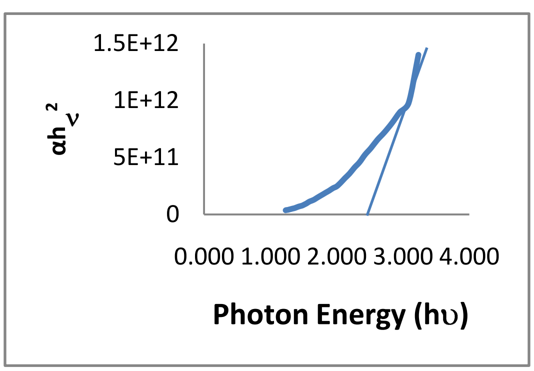


Fig: 7b The optical energy gap for the direct allow transition of CdO thin Film thickness, t= 0.4391 μm

Fig:8b The optical conductivity of CdO thin Film as a function to the photon energy, thickness, t= 0.4391 μm



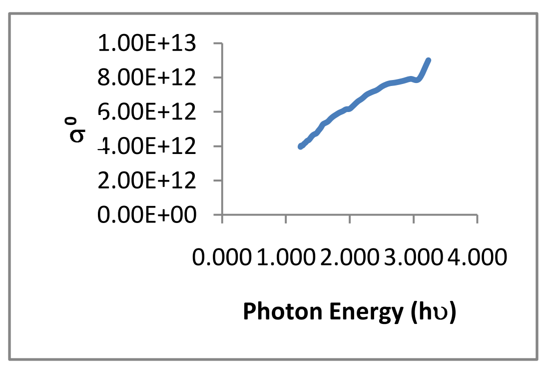


Fig:7c The optical energy gap for the direct allow transition of CdO thin Film thickness, t= 0.5248 μm

Fig: 8c The optical conductivity of CdO thin Film as a function to the photon energy, thickness, t= 0.5248 μm

Conclusion :

CdO thin films have been prepared from different molar concentrations of Cadmium Chloride onto glass substrate keeping the substrate temperature 300°C using a simple Spray Pyrolysis method. Optical and structural properties have been studied with the variation of molar concentration [0.01M, 0.025M, 0.05 M], the thickness of the deposited thin films changes from 0.4170μm -0.5248μm

The SEM micrograph of as deposited films show homogenous deposition over the substrate. SEM micrographs exhibit clear grains and gain boundary formation. It is observed that the band gap decreases with the increase of the molar concentrations of the Cadmium Chloride aqueous solution. The optical band gap was found to vary from 2.24eV-2.49eV. These results are in good agreement with other reported values.

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