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STRUCTURAL INVESTIGATION OF CADMIUM OXIDE THIN FILM (CONCENTRATION DEPENDENCE)

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ABSTRACT- Cadmium Oxide thin films have been deposited on Indium doped Tin oxide (ITO) substrate using the electrodeposition method. CdO chosen due to high electrical conductivity, good optical transparency and moderate refractive index. The X-ray diffraction spectra shows the CdO thin films are polycrystalline with the fcc structure. The elemental composition and surface morphology were studied using EDAX and Scanning Electron Microscopy. The optical properties of prepared thin films are determined using UV- Visible and photoluminescence spectroscopic techniques.

Keywords- [Electrodeosition method, XRD, SEM, EDAX]

1. INTRODUCTION

Cadmium oxide is one of the recently studied transparent conducting oxides whose properties are under study to understand its intrinsic behaviour as a transparent conducting oxide. Cadmium oxide is one of the promising transparent conducting oxides from II to VI group of semiconductors. CdO films have been prepared so far by different techniques such as chemical bath deposition [1], pulsed laser deposition [2], sol-gel [3], magnetron sputtering [4], metal organic chemical vapour deposition [5] , hydrothermal method [6] , electron beam evaporation technique [7] and Successive Ionic Layer Absorption and Reaction (SILAR) methods [8] . Electrodeposition is one of the methods and it is a very efficient technique to develop device quality thin films of larger area with reasonable cost. Cadmium oxide have potential applications in Photovoltaic Solar cells, Phototransistors, liquid crystal displays, optical heaters, gas sensors, transparent electrodes and other optoelectronic devices [9-11]. In the present work, preparation and characterization of CdO films growth by electrodeposition on various concentrations like 0.1N & 0.2N is studied and the structural, morphological, and optical properties have been discussed.

2. EXPERIMENTAL AND METHODS

Cadmium oxide thin films were electrodeposited on an indium doped tin oxide (ITO) glass substrates. ITO substrate was cleaned (ultrasonically) for 5 minutes in acetone and ethanol. The etching process was carried out for 2 minutes in dilute nitric acid and finally washed with deionised water. The bath was composed of cadmium chloride which is the source of cadmium ion. They consist of ITO glass substrates as a working electrode, a platinum wire as a counter electrode and silver-silver chloride as the reference electrode separately. The

deposition parameters like temperature (room temperature) of the bath, deposition time (20 mins) and deposition current (1mA) are optimized for the well adherent, uniform and pinhole free thin film. The electrodeposition of the thin films was carried out at room temperature. The deposition was carried out for 0.1N and 0.2N. The prepared samples were characterized by XRD, SEM with EDAX, UV- Vis Spectrophotometer and PL.

The phases of the samples were identified by Powder X-ray diffraction method. Powder X-ray diffraction patterns of the samples were obtained by using Bruker Eco D8 Advance X-ray diffractometer. The surface morphology and composition of CdO thin films were examined by means of BRUKER DS Advance scanning electron microscope and EDAX. The optical absorption spectra for the electrodeposited films on ITO substrate were taken using a SHIMADZU UV2410S spectrophotometer. The PL emission spectra of samples were recorded at room temperature using spectrofluometer equipped with a 450 W Xenon lamp as the excitation source. .

3. RESULTS AND DISCUSSION

3.1 X-Ray Diffraction:

The X-ray diffraction patterns were obtained employing a BRUKER ECO D8 Advance spectrometer using CuKα radiation in the 2θ range 10^0 to 90^0. X-ray generator was operated at 40 kV and 20 mA. The d-spacing values of the sample matches well with standard JCPDS file No: 62-2908 and the X-ray diffraction pattern obtained from the films deposited with concentration 0.1N and 0.2N are shown in Fig 1a and 1b. The spectra exhibits three bragg peaks among which peak orientation (2 0 0) was prominent. The structure of the CdO thin film is face centered cibic (FCC) structure, these peak values of the sample were confirmed the deposition of cadmium oxide.

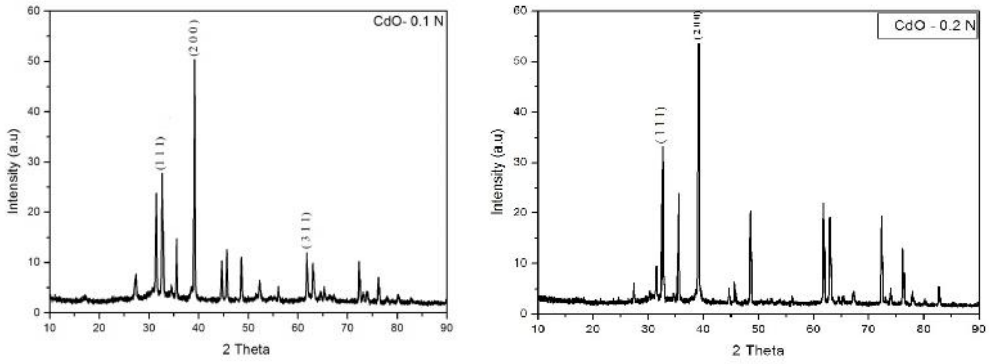

Figure 1- a- XRD Image for Cadmium Oxide (0.1 N) Figure 1 b- XRD Image for Cadmium Oxide (0.2 N)

3.2 MORPHOLOGICAL STUDIES:

The morphology and microstructure of the CdO samples (0.1 N & 0.2N) were examined by Scanning Electron Microscope. The surface morphology of the particles was operated at accelerating 20 kv potential, film deposited at a room temperature has shown in Fig 2 & Fig 3. For 0.1N the grains with random shape and size. It can be seen that all the substrates are fully covered by Cadmium oxide particles. Film exhibits worm like structure grains without any cracks and pinholes of the surface. For 0.2N, irregular shaped particles are grouped each other and some particles are spherical agglomerated. A uniform morphology and chemical homogeneity is also observed in the image. The SEM images showed that the good adhesion of the film to the substrate. As deposited film reveals that the ordered microstructure encompassing closely packed microstructures.

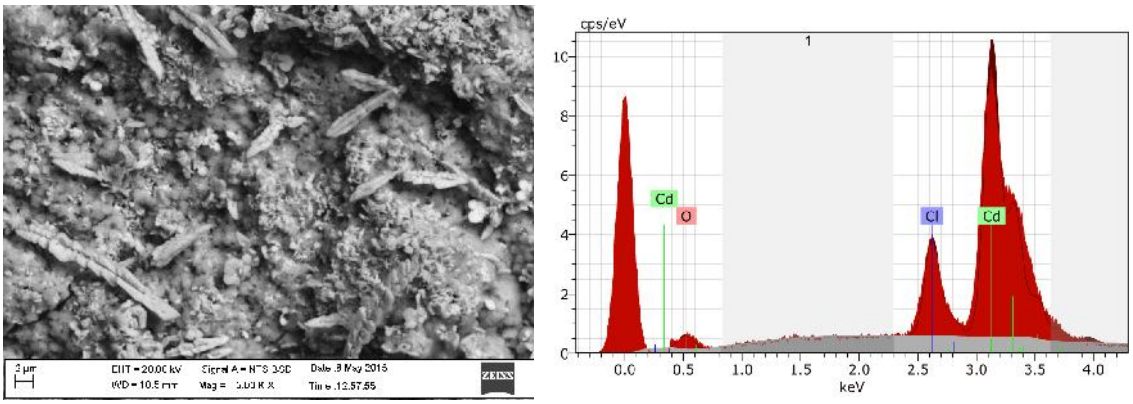

Figure 2- SEM with EDAX images of Cadmium oxide (0.1N) as deposited on ITO plate

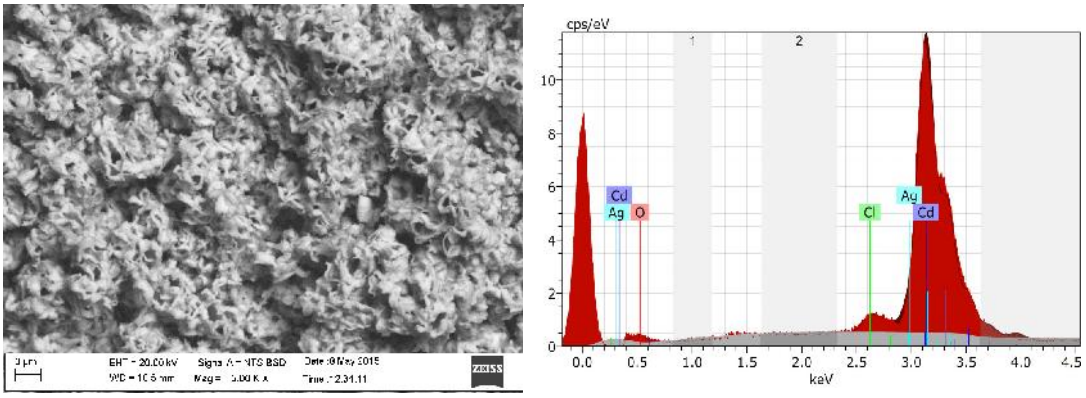

Figure 3- SEM with EDAX images of Cadmium oxide (0.2N) as deposited on ITO plate

EDAX is used in conjucntion with SEM for chemical microanalysis technique.From EDAX spectra, the atomic percentages of Cadmium and Oxygen were recorded as 41.33 and 41.66 respectively for 0.1 N and , the atomic percentages of Cadmium and Oxygen were recorded as 56.25 and 34.63 respectively for 0.2 N. The results indicated that the presences of Cadmium oxide particles deposited on the substrate.

3.3 UV STUDIES

The spectral absorbances of the sample CdO for 0.1N and 0.2N are as shown in Fig: 4 a and Fig 4 b. The optical absorption spectra of the films in spectral range of 400 – 800 nm was determined by using UV-Vis- Spectrophtotometer. It indicates that the films have low absorbance int he UV region and the films absorption spectra was decreased with increase concentraution.

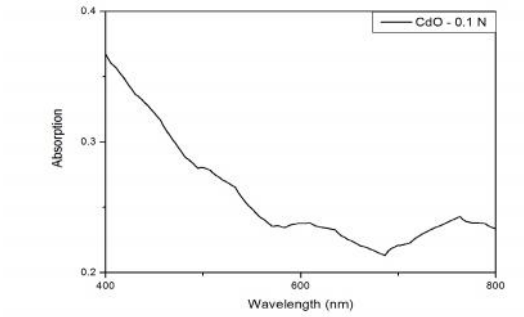

Figure 4- a- UV image for Cadmium Oxide (0.1 N)

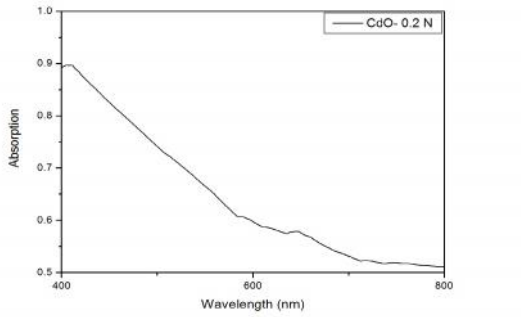

Figure 4- b- UV image for Cadmium Oxide (0.2 N)

3.4 PHOTOLUMINE SCENCE SPECTRA

Room temperature Photoluminescence (PL) spectra of CdO films measured in the visible region are shown in Fig 5. PL emission spectra were carried out at an excitation wavelength at 346 nm for 0.1N and 0.2 N CdO films prepared by electrodeposition method. There are two emission peak obtained. The peak appeared at 306 nm (4.05eV) for 0.1 N and 290 nm (4.27eV) for 0.2 N are attributed to transition between states at the bottom of the conduction band and top of the valence band of the CdO thin film and band edge emission [12,13]. The emission peaks centred at 347 nm (3.57 eV) for 0.1N and 343 nm (3.61 eV) for 0.2 N are assigned due to an excitation bound to a donar level [14]. The defect related luminescence peak is obtained with broad band due to radiative transitions between oxygen vacancies. The peak located at around 343nm and 347 nm corresponds to the ultraviolet emission caused by the recombination of free excitations. The luminescence intensity decrease with increase concentration in cadmium oxide, its intensity falls lower but still remains in the conduction band.

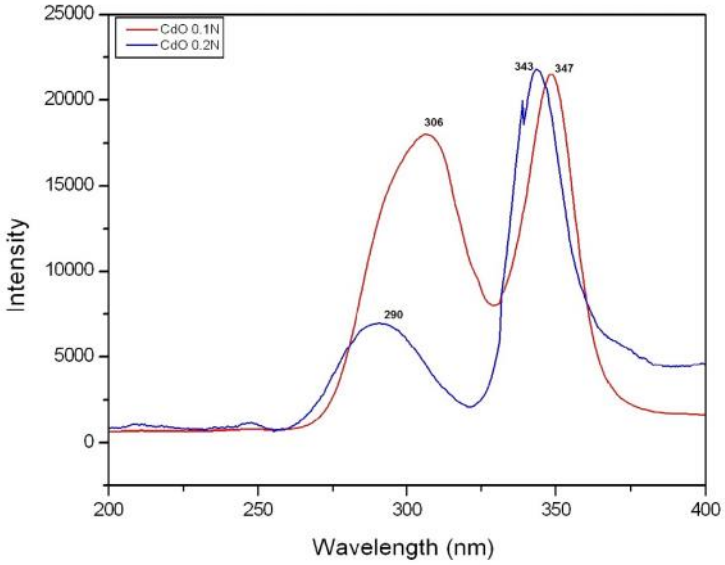

Figure 5- PL Spectra of Cadmium oxide for 0.1 N and 0.2 N

CONCLUSION

In conclusion, we synthesized cadmium oxide thin film prepared at different concentration like 0.1N and 0.2 N using electrodeposition methods. Face centred cubic structure CdO thin film is synthesized. The morphology of CdO thin film was analyzed using SEM image which results uniform morphology and chemical homogeneity is observed. PL spectra show sharp emission around 343 and 347 nm. It is found that the film deposited on ITO substrate at different concentration which exhibits a better structural characteristics.

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