# Development of Nanostructured Cadmium Oxide (Cdo) Thin Films

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## Abstract

*A nanostructured thin film of cadmium oxide (CdO) have been obtained from cadmium sulphide (CdS) films by annealing process in air at temperatures between 400ºC and 750ºC. The CdS films have been fabricated onto glass substrates using simple & inexpensive chemical bath deposition technique (CBDT). The optical & structural characterization of obtained materials was performed. The x-ray diffraction (XRD) study has confirmed the formation of CdO with nano-size scale whereas the scanning electron microscopy (SEM) studies showed that all the films were polycrystalline in nature. The optical energy band gaps of the films were evaluated. The nano-crystalline materials exhibiting small particle size & large surface area may be applied for various gas sensors as well as in large area electronic devices.*

**Keywords:** cadmium oxide, nanocrystals, gas sensor, thin films.

## Introduction

The semiconductor oxides such as CdO, ZnO, BaO, Fe2O3, and Cu2O thin films have been studied extensively as a result of wide range of technical applications[1, 2]. Semiconductors are of considerable technical interest in the field of electronic and optoelectronic devices [3].

The commonly used methods of preparation of semiconductor thin films are spray pyrolysis, sputtering, sol gel, vacuum evaporation , PLD, chemical bath deposition technique (CBDT), etc. CBDT is most common but inexpensive and convenient and controllable method for large preparation of thin films at low temperatures [4, 5].

In this work, we present a new approach to fabricate nanostructured CdO thin films by post thermal annealing treatment over CdS thin films prepared by using controlled chemical reaction bath and their physical properties have been investigated.

## Material and Methods

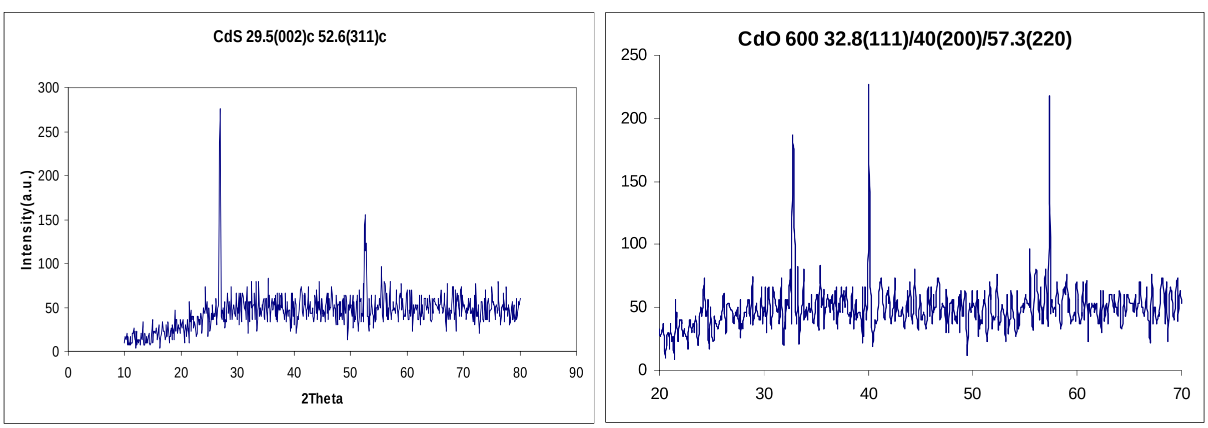
To prepare CdO films, aqueous solutions of cadmium sulphate and thiourea with calculated proportion was added in 130 ml of de-ionized water. Complexing agent ammonia was added slowly to adjust the pH between 9.5 and 10. The solution was stirred and transferred to another container containing substrate. The resulting solution was kept at 70±2ºC for 1 hour. The substrate used is commercial glass slide. Cleaning of substrate is important in fabrication of thin films, cleaning steps and growth procedure is reported elsewhere [6-9]. After 20-30 minutes the bath solution in beaker turned yellowish, thus indicating the onset CdS deposition on the glass slide. After a reaction time of 1 hour the glass slides were taken out and dried in air for 15 minutes. Then for the post annealing treatment in air, the prepared CdS films were kept in the oven at various temperatures between 400ºC and 750ºC for 10 hours. The CdS films get oxidized in the oven to form thin films of CdO.

The crystallographic structure of films was analyzed with x-ray diffractometer (EXPERT-PRO) by using Cu-Kα lines (λ= 1.542Å). The average grain size in the fabricated films was obtained from a Debye-Scherrer's formula. Surface morphology was examined by JEOL model JSM-6400 scanning electron microscope (SEM). The optical transmission spectra for a range of samples were obtained in UV-VIS-NIR region using Perklin-Elmer UV-VIS lambda-35 spectrometer.[9].

## Results And Discussion

### XRD analysis

Fig. 1 shows the X-ray diffraction pattern of CDS thin films and CDO thin film obtained from post annealing treatment over CDS films at various temperatures. The XRD pattern confirms that the CDS films get oxidized in the oven to form CDO thin films. It was found that cubic structured CDS is completely oxidized at higher annealing temperature to form an hexagonal CDO. The film shows reflections from (111), (200) and (220) planes at 600°C, indicating the formation of CDO nano particles having pure hexagonal structure (matches with JCPDF data).




(a) (b)

Fig.1. XRD patterns of CdS and CdO thin film fabricated at 600ºC

The average size of grain (g) have been obtained from the XRD patterns using Debye-Scherrer's formula, [9-12]

$$g = K\lambda / \beta \cos\theta$$

Where,

K = constant taken to be 0.94,

$\lambda$ = wavelength of X-ray used (1.542Å),

$\beta$ = FWHM of the peak and

$\theta$ = Bragg's angle.

The grain sizes were found to be within the range from 16 to 29nm. This confirms the good crystallinity of the samples. The grain size obtained from SEM matches with the grain size obtained from XRD.

## Optical Study

The optical energy band gap (Eg) was determined by plotting (αhν)2 versus hν and then extrapolating the straight line portion to the energy axis at α =0 (Fig. 2). It was observed that the band gap of the film obtained at higher annealing temperature is 2.31eV.

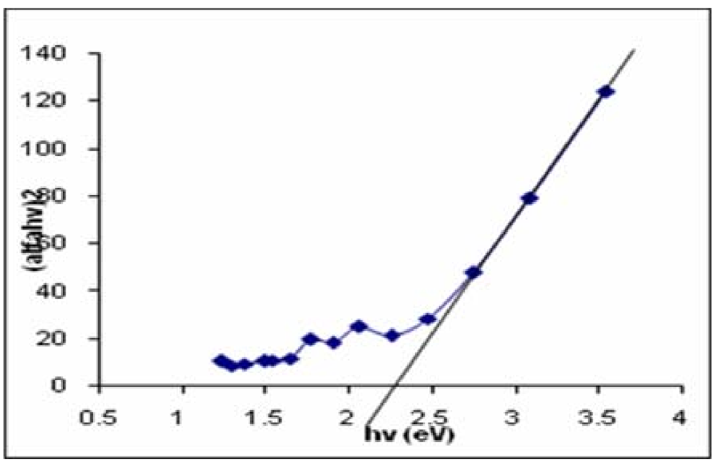



Fig.2. Plot of (αhν)2 vs hν for CdO thin films fabricated at 600ºC

## Conclusions

Nano-structured CdO thin films were successfully fabricated by post annealing treatment over CdS thin films prepared by CBDT. The X-ray diffraction analysis showed that film is polycrystalline with pure hexagonal structure. The grain size estimated is in the range of 16 to 29nm. This small grain size makes the films applicable for the gas sensors. The film has a direct band gap with an optical value of 2.31eV which is in good agreement with the standard value. This makes the films suitable for various optoelectronic and sensor applications.

ISSN:2319-6602
International Journal of Chemical and Physical Sciences

**Acknowledgement**

The author is grateful to Head, Department of Metallurgy, VNIT, Nagpur for providing XRD & SEM facilities. We would also like to acknowledge Head, CIC, SGB Amravati University for UV-VIS-Near IR facilities.

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