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Temperature influences study on cadmium oxide nanoparticles

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Abstract - *Cadmium oxide nanoparticles have been prepared by the chemical precipitation method. The structural, morphological and optical properties were investigated by annealing at three different temperatures 300^0C, 400^0C and 500^0C. The synthesized nanoparticles were characterized by X-ray diffraction analysis (XRD), scanning electron microscope (SEM), UV-Vis absorption photoluminescence studies and FTIR spectra. The XRD pattern reveals that, CdO sample has face centered cubic structure. The morphological studies show that the accumulation of particles at different temperature. The optical energy band gap (E_g) showed a decrease from 2.36 to 2.39 eV with increasing temperature. Change in luminescence intensity due to cadmium interestial and oxygen vacancy defects of nanoparticles. FTIR analysis confirmed Cd- O bond formation in the synthesized nanoparticles.*

Keywords: *Cadmium Oxide nanoparticles, FTIR, UV and XRD.*

I. INTRODUCTION

Metal oxides have long been subject of various investigations due to their unique physical properties and applications in commercial devices [1, 2]. Cadmium oxide is a n-type semiconductor used as a transparent conductive material. Cadmium oxide possesses high transparency in the visible region of solar spectra. Cadmium oxide has a range of applications such as solar cells, photo transistors, photovoltaic cells, transparent electrodes and gas sensors [3-8]. The Cadmium oxide nano particles were also synthesized by hydrothermal, sol-gel, and chemical precipitation method.

II. EXPERIMENTAL METHODS

This paper deals with the preparation of CdO nanoparticles using chemical precipitation method. The aqueous solution to cadmium chloride is prepared by dissolving $CdCl_2$ in deionized water. As cadmium chloride is soluble in water, it will dissolve completely in deionized water within 30 minutes and yield transparent solution. Then, ammonium hydroxide solution was slowly added drop by drop to the transparent solution. After 3 hours of stirring, a whitish cloudy solution is obtained. The white precipitates were formed, and it was allowed to settle for overnight. Then, filtered and washed several times using distilled water. It was dried at 100 °C for 6 hours and then grinded using mortal piestel. The resulting powder was annealed at 300 °C, 400 °C and 500 °C for 2 hours.

The CdO nanoparticles were prepared by precipitation method and the samples were annealed at different temperatures 300 °C, 400 °C and 500 °C. The prepared CdO nanoparticles were characterized by XRD, SEM, UV, PL and FTIR. 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 nanoparticles was examined by means of BRUKER DS Advance scanning electron microscope and EDAX. The FTIR spectra were taken on Perkins Elmer 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.

III. RESULTS AND DISCUSSION

A. XRD Analysis:

From the XRD spectra, the prominent peaks have been utilized to estimate the grain size of the sample with the help of Scherer equation. The peaks corresponding to the planes (1 1 1) (2 0 0) (2 2 0) (3 1 1) (2 2 2) (4 0 0) (3 3 1) (4 2 0) (4 2 2) are in good agreement with JCPDS values (71-0476). The maximum intense peak corresponding to the plane (3 1 1) reveals that the presences of CdO. It is clear about the XRD spectra that all peaks correspond to fcc structure of CdO and no other impurity peaks are found. The peaks are broad due to nano size effect. The grain size can be calculated by Debye- Scherer's formula from full width half maximum. The average grain size increases from 27 nm to 37 nm as the temperature increases. The sharp peaks indicate that the particles were of polycrystalline structure, and that the nanostructure grew with a random orientation [9]. Lattice constant, grain sizes and dislocation density of nanoparticles continues to decrease with increase in annealing temperature. Change in lattice constant may be due to change in grain size of annealing.

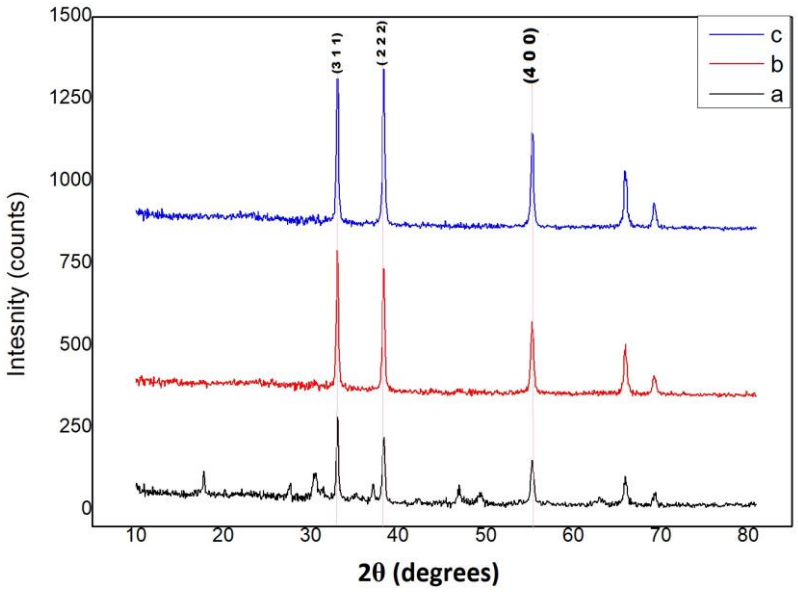

Figure 1: XRD pattern of the CdO nanoparticle (0.5 M) annealed at (a) 300 °C (b) 400 °C and (c) 500 °C

Table1: Micro Structural Properties of CdO nanoparticle (0.5 M)

Micro Structural Properties / Samples	Grain Size using Debye-Scherer's formula (nm)	Strain ($x10^{-3}$)	Dislocation Density(/m²) $x10^{15}$	Texture Coefficient	Lattice constant (a)
300^{0}C	27.4332	1.7215	2.9909	1.8191	6.06
400^{0}C	26.1305	1.6515	2.8143	1.7752	6.04
500^{0}C	27.9582	1.1524	1.2001	1.6052	6.03

B. Morphological Studies:

SEM analysis:

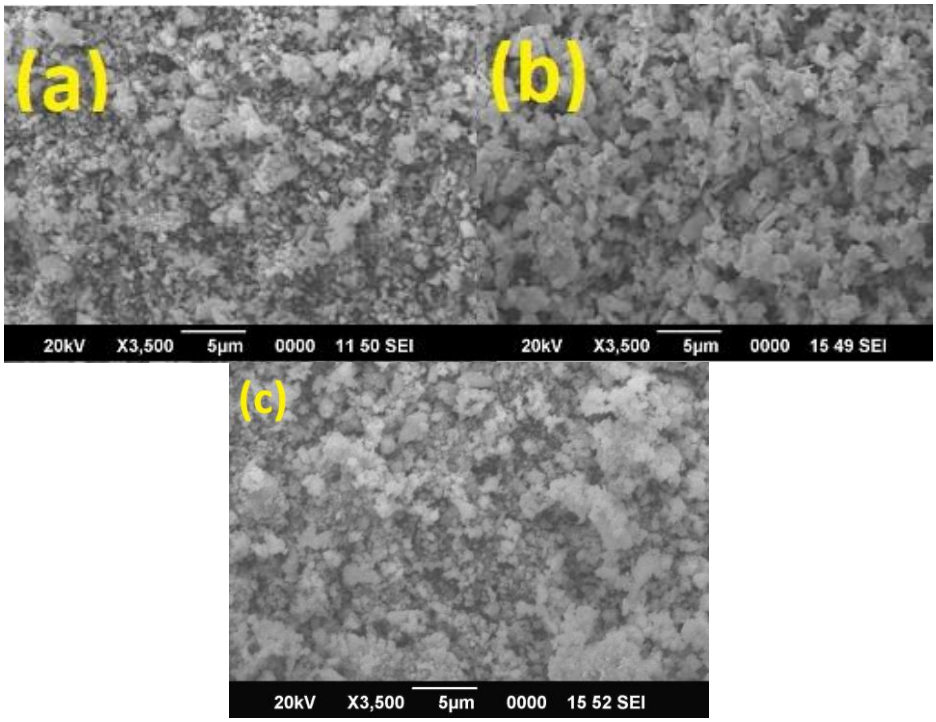

Figure 2 (a). SEM image of the CdO nanoparticle (0.5 M) annealed at (a) 300 °C (b) 400 °C and (c) 500 °C

From the SEM images, it is clear that the particles were accumulated with respect to different temperature. The SEM pictures clearly show that the particles accumulation increases when annealing. From the SEM analysis, the formation of nanoparticle's is in cubic structure. A cubic pattern of spots is the highly crystalline nature of CdO. The image reveals that the average grain size is 26 nm.

The EDAX spectra reveal that the elemental composition of Zinc and Oxygen are present in the samples.

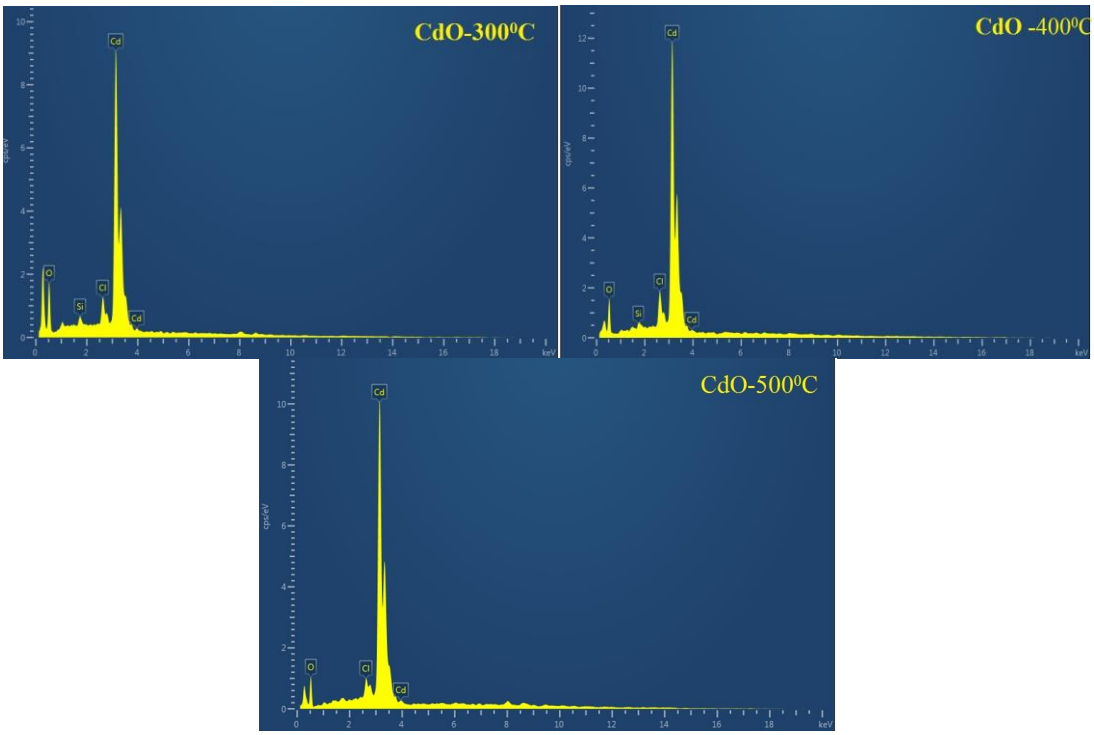

Figure 2(b). EDAX Spectra of the CdO nanoparticle (0.5 M) annealed at (a) 300 °C (b) 400 °C and (c) 500 °C

C. OPTICAL STUDIES:

UV – Visible spectral analysis:

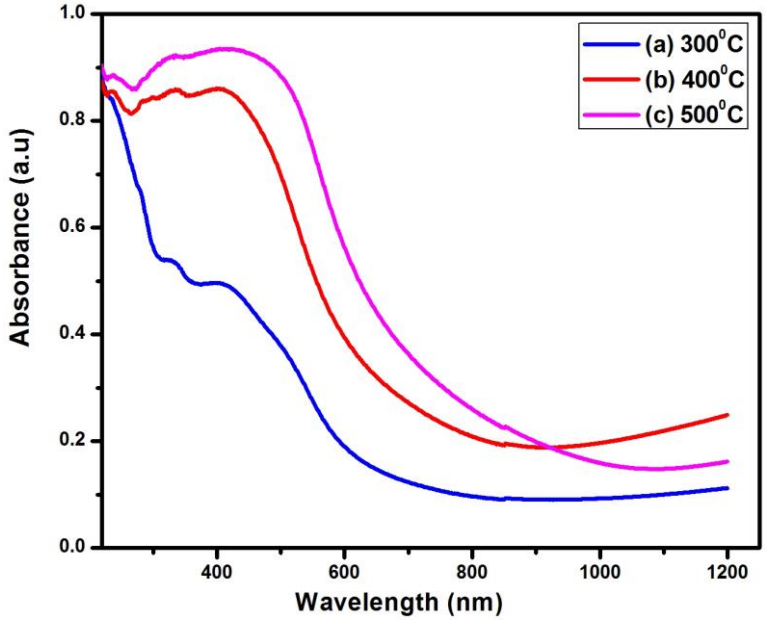

Figure 3:Absorption Spectra of CdO nanoparticle annealed at (a) 300 °C (b) 400 °C and (c) 500 °C

UV-Vis absorbance spectrum of CdO nanoparticle is in the range of 350 – 450 nm [10]. The absorption spectra for CdO nanoparticles synthesized at 300 °C, 400 °C, and 500 °C are shown in Figure. It is evident that all the samples exhibit the well-defined absorption band edges at 321, 330, and 356 nm. The band gap energy of the CdO particles corresponding to the absorption edges is discovered to be 3.86, 3.76, and 3.48 eV, respectively. The band gap between

semiconductor materials increases to the decrease in particles size, which leads to the shift of the absorption edge of high energy; this is the so-called quantum size effect.

Photoluminescence spectra:

The photoluminescence spectra of the nanoparticles are taken at room temperature. From the PL spectra of the CdO sample, the emission peaked at 620 nm due to airfact which arises because of lamp source [11]. From the spectra, it was found that annealing red shifted emission peak positions of sample annealed at 400 °C and 500 °C. Intensity of blue emitting peak of 500 °C sample was increased to a greater extent. Intensity of peak of both 400 °C and 500 °C samples increased than that of 300 °C. This is because annealing at 500 °C increases the number of Cd-interstitial vacancies by providing enough ionization energy [12].

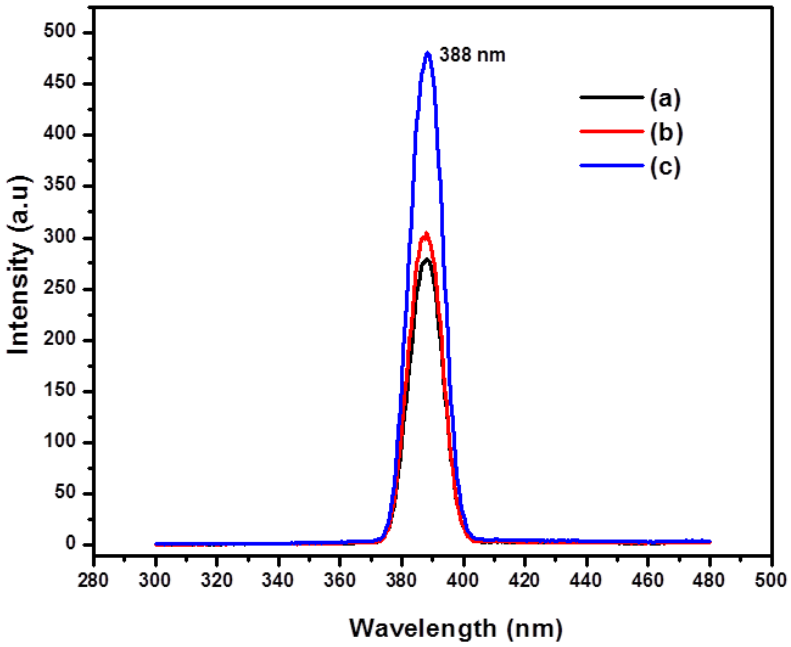

Figure 4. Excitation spectrum of CdO nanoparticle (0.5 M) annealed at (a) 300 °C (b) 400 °C and (c) 500 °C

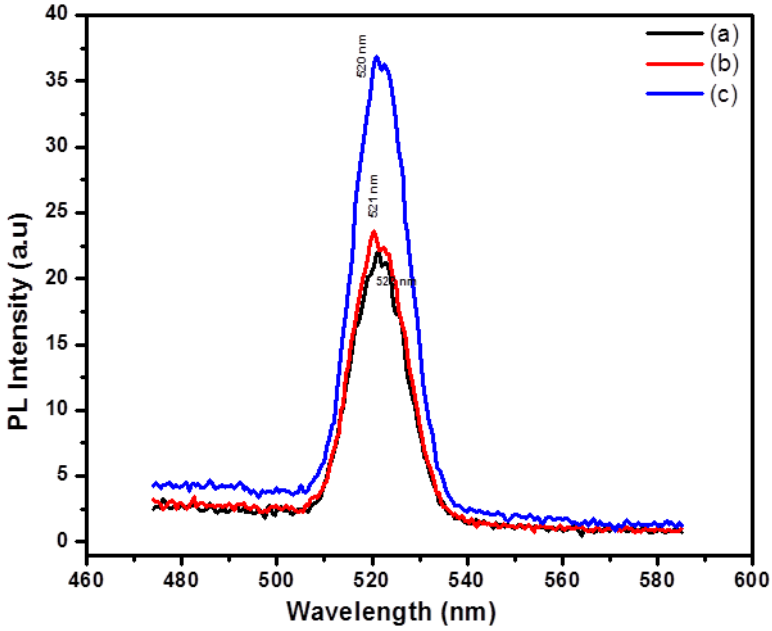

Figure 5. Emission spectrum of CdO nanoparticle (0.5 M) annealed at (a) 300 °C (b) 400 °C and (c) 500 °C

FTIR Studies:

Figure 6 shows FTIR spectra of Cadmium oxide nanoparticles at three different temperatures. The observed peaks are related to the organic groups of the precursor. The appeared peaks at 1633 and 1346 cm^{-1} are assigned to C=O and C-O stretching vibrations of the carbonyl groups, respectively. The peak at 1250 cm^{-1} and comparatively two small peaks corresponds with the presence of cadmium and oxygen in the nanoparticles.

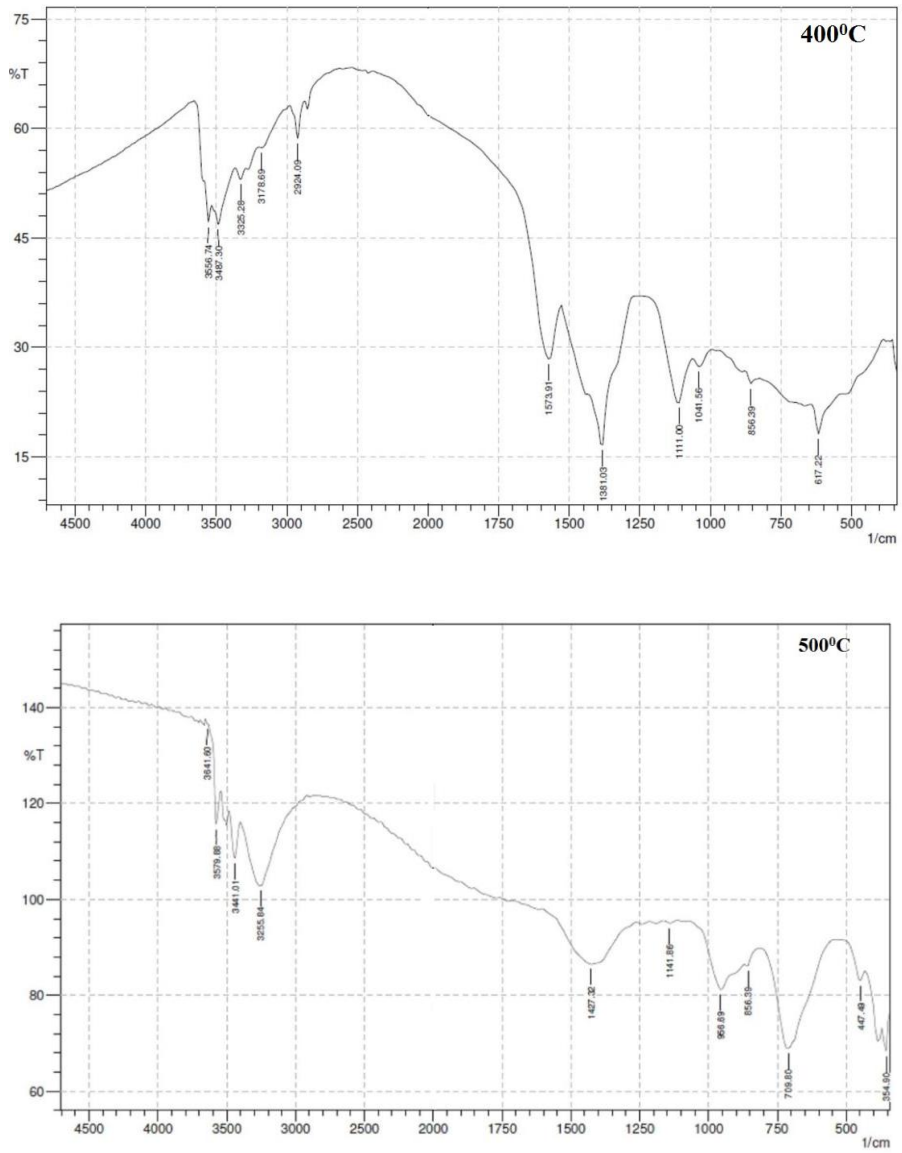

Figure 6. FTIR Spectra of CdO nanoparticle at 300 °C, 400 °C & 500 °C

IV.CONCLUSIONS

CdO nanoparticle has been synthesized by chemical precipitation method using very easy, cheap and convenient process. The formation of CdO nanoparticles was confirmed by XRD analysis. CdO nanoparticles annealed at different temperatures revealed face-centered cubic phase for all temperatures. The SEM images also show that as the annealing temperature is increased, the slide surface becomes smooth. IR and UV-Vis spectral studies show presence of CdO bonds. CdO nanoparticles synthesized at different temperatures show the well-defined absorption band edges, with corresponding narrow band edge photoluminescence emissions.

REFERENCES

[1]. D.M. Carballeda-Galicia, R. Castaneod-Perez, O.Jimenez-Sandoval, S. Jimenez-Sandoval, G.Torres Delgado, C.I. Zuniga-Romera, *Thin Solid Films*, 371, 2000, 105-108.
[2]. Y. Caglar, S. Ilican, M. Caglar, *Eur. Phys. J. B*, 58, 2007, 251-256.
[3]. L. M. Su, N. Grote, F. Schmitt, *Electron. Lett*. 20, 1985, 716.
[4]. Su L M, Grote N, Schmitt F, *Electron Lett*. l20, 1984, 717.
[5]. C. H. Champness, K. Ghoneim, J. K. Chen, *Can. J. Phys*. 63, 1985, 767.
[6]. F. A. Benko, F. P. Koffyberg, *Solid State Commun*.Vol57, 1986,pp. no.901.
[7]. K. Gurumugan, D. Mangalarag, A. Narayandass, K. Sekar, and C. P. GirijaVallabham, *Semicond. Sci. Tech*. 9, 1994, 1827.
[8]. C. Xiangfeng, L. Xingqin, M. Guangyao, *Sens*. *Actuators* BVol65, 1995,pp. no.64.

[9]. H.P. Klug, and L.E. Alexander, X-ray Diffraction Procedures for Polycrystalline and Amorphous Materials, Wiley, New York (1954).
[10]. P. Jha, S. Rai, K. V. Ramanujachary, S. E. Lofland, and A. K. Ganguli, *Journal of Solid State Chemistry*, 177, 8, 2004, 2881–2888.
[11]. A.S.Lanje, R.S.Ningthoujam,S.J.Sharma and R.B.pode, *Indian.J.Pure & Appl. Physics*, 49, 234-238, 2011.