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Study the Optical and Structural Properties for Nano CdO Prepared by Plasma –Get Technique

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ABSTRACT

In the present study, nanoparticles of cadmium oxide have been prepared from bulk structures by the induced plasma technique at different bombardment times. These nanoparticles were prepared as thin layers on glass substrates with different thicknesses (prepared at different times of shelling). After that, they were analyzed with a UV-visible spectrophotometer, scanning electron microscope (SEM), atomic force microscope (AFM), and X-ray spectrum. When the optical properties and their constants were measured, the energy gap of the films increased in the range of 2.94–3.2 eV with bombardment times. The examining images of AFM and SEM show a clear variation in the structure, where the roughness varies with bombardment time due to the variation in the nanoparticles' diameter. Finally, the x-ray spectrum shows that the layers are completely crystalline.

Keywords: Plasma-Get, Optical properties, Structural properties, Energy gap, Roughness and Nano particles

I. INTRODUCTION

Cadmium oxide is soluble in acids only while it is insoluble in water and alkalis[1]. It is one of the (II-VI) group compounds and has a cubic crystal structure with face-centered (FCC) unit cells similar to the structure of a crystal of sodium chloride (NaCl) figure .1 [2,3,4]. Cadmium oxide. It is a semiconductor material within the group of transparent conductive oxides (TCO) and has distinct properties, including a relatively large energy gap range of 2.2–2.7 eV. [5,6,7], transparency in the visible region Near infrared rays (NIR) [8, 9], high reflectivity in the red region of the electromagnetic spectrum [1011], high mobility of carriers [12], high electrical conductivity similar to the conductivity of negative-type metals (n-type) [3,8], and has good fluorescence, cadmium oxide has many applications such as electro-optical devices[13], phototransistors [14], biological and catalytically applications [15], and gas sensors[16]. Several techniques have been used in the preparation of Cadmium oxide thin films, such as magnetron sputtering [17,18], sol gel method [19] and Spray Pyrolysis Technique[20].

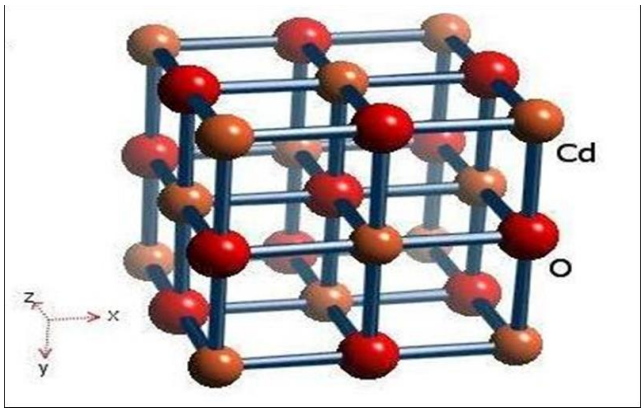


Figure (1): A diagram of the CdO crystal structure [16].

II. PREPARATION METHOD

Solutions containing nanoparticles were prepared by the induced plasma deposition method for different preparation periods 4, 6, 8, 10 min. Cadmium metal foils 99% purity have been used as a source for cadmium. The cleaning of the foils was carried out using polishing paper and then washed with ethanol alcohol to remove any impurities present on the surface of the metals.

Where the cadmium metal before placing it in the glass beaker had dimensions of length and width of about 10 cm^2, after that, a part of the cadmium metal was cut to about 1.5 cm^2 , it will be immersed in a 10 ml glass beaker containing 7 ml of distilled water .Where the nozzle of the needle is directed in the middle of the metal ,If a needle nozzle is located at a distance of 7 cm^2 from the target , then in order to generate a spark in the form of a scattered blue flame , the metal foil will be connected to the positive electrode while the negative electrode will be connected to the needle nozzle. The process will be carried out in the presence of argon gas that flows at a constant rate (3L/sec) Figure(2) showing the operation of the induced plasma system.

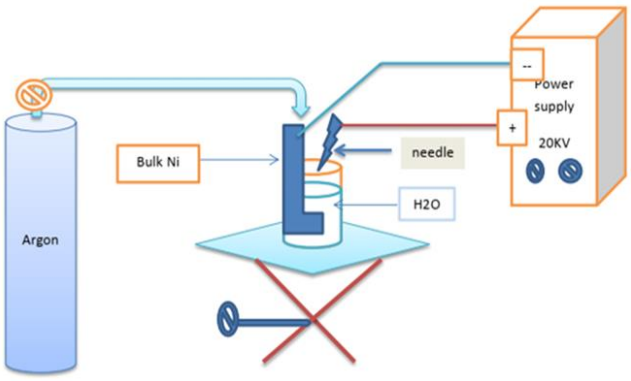


Figure.(2): Explain the operation of the induced plasma -jet

III.RESULTS AND DISCUSSION

The cadmium oxide CdO particles have been prepared using the plasma-jet technique for different preparation periods (bombardment) in the range of 4, 6, 8, and 10 min. The optical properties of CdO particles in each solution were taken. Figure. 3 shows the optical properties and constants for the solution that was prepared at different periods. The transmittance, absorbance, and reflectance were varied rapidly over the range of 300~400 nm and then extremely saturated for the longer wave lengths. This change also occurs similarly in the optical constants and for the same range of wavelengths, where we notice the refractive index and the extinction coefficient decrease with wavelength in the range of 300~400 nm and then become extremely constant for the other longer wavelengths .The calculated band gap for all solutions changed clearly in tabel.3 and figure 6-f. The band gap for the particles prepared at 4 min was 2.96 eV, then decreased to 2.94 eV for the particles prepared at 6 min, while it increased to 3.1 eV and 3.2 eV for the particles prepared at 8 and 10 min, respectively. The fluctuation in the band gap is due to the variation in the grain size , where we note that the energy gap increases when the grain size approaches the Nano scale. Table. 2and 3 shows the change of the grain size and energy gap with time.

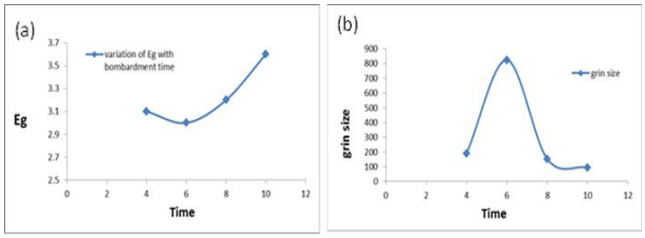
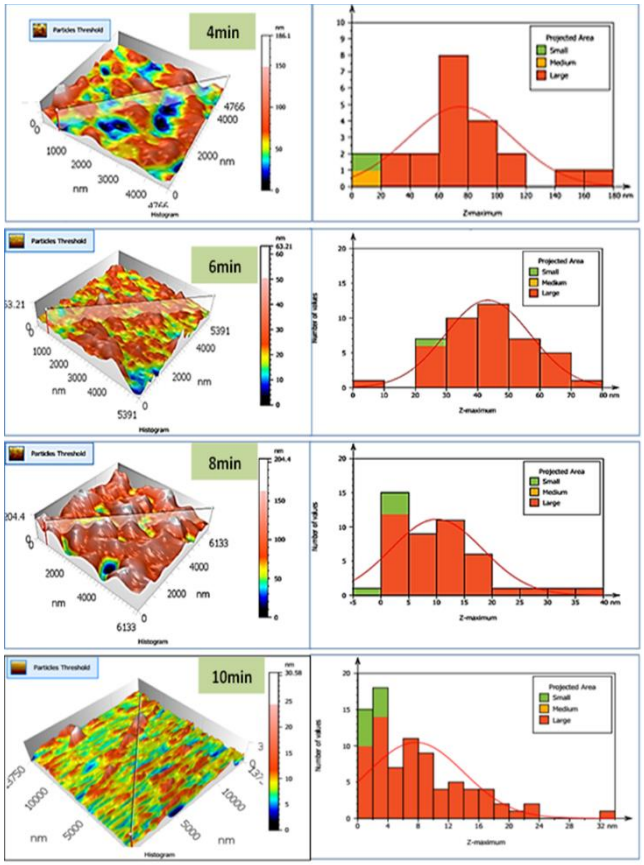


Figure. (3): (a) Variation in E_g with bombardment time; (b) Variation in grin size with bombardment time

Atomic force microscope images show that the grain size varied with preparation period, the images show that the grain size decreases with deposition time and this agree with x-ray spectrum where the peaks shifted to blue region . The surface roughness is also decreases with bombardment time table (1).



Figure(4): Structural properties of CdO after plasma-get bombardment for different bombardment periods (4,6,8 and 10) min

TABEL. 1

AFM measurements and energy gap for the prepared samples at various bombardment times.

bombardment time (min)	Surface Thickness(nm)	Roughness Average (nm)
4	74.75	7.491
6	43.27	8.00 9
8	10.04	5.150
10	7.678	1.059

X-ray spectrum show that the layers are extremely crystalline with cubic structure for all bombardment periods, the peaks for all periods appear with small differences in 2θ and small differences in intensities, which is reflected in the calculated grain size, the grain size decreases with bombardment period as in table (2) , and this agree with AFM images.

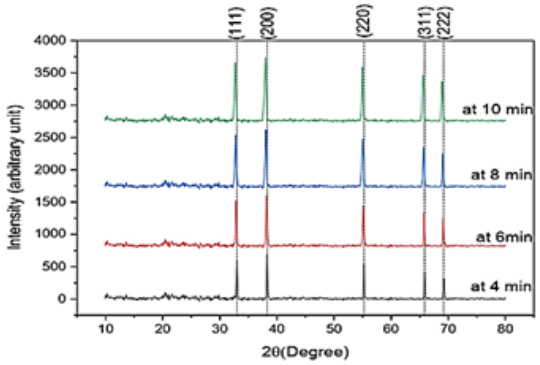


Figure 5: Shows the X-ray diffraction of CdO metal oxide after preparing it with induced plasma bombardment with different times.

TABLE. 2

SHOW THE AVERAGE GRAIN SIZE FOR DIFFERENT BOMBARDMENT TIME

Bombardment time	Average grain size
4min	**5.4**
6min	**4.9**
8min	**3.9**
10min	**3.5**

SEM images show that the grain size decreases with bombardment time as shown in figure (5) , and this agree with X-ray and AFM measurements.

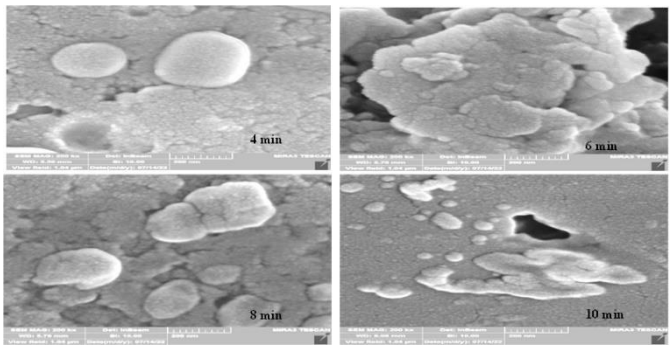


Figure. (6): show SEM images of CdO prepared at different bombardment periods (4,6,8,10)min

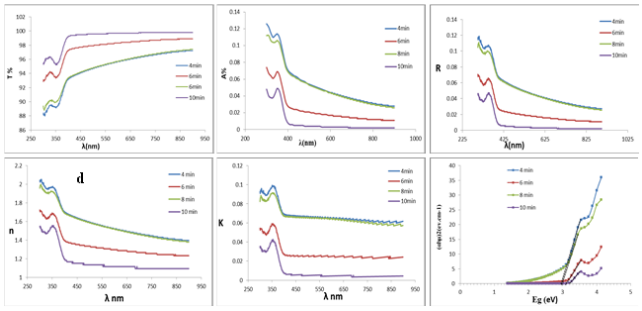


Figure.(7): effect of bombardment time on the optical properties a. transition b. absorption c. reflective d. refractive index e. extinction coefficient f. energy gap.

TABEL 3

band gap of the CdO prepared at different bombardment periods

bombardment time (min)	Energy gap (eV)
4	2.96
6	2.94
8	3.1
10	3.2

IV. CONCLUSION

Cadmium oxide nanoparticles have been prepared using the plasma-Get technique for different bombardment periods. AFM images show that the roughness and surface thickness decrease with bombardment periods, and this agrees with SEM images and the X-ray spectrum. The X-ray spectra show that the layers are completely crystalline; ,the peaks for all periods appear at the same 2 with different intensities. In addition, the calculated grain size decreases with periods from 5.4 to 3.5 nm. The optical properties and energy gap varied clearly with bombardment periods.

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