International Journal of Nanoelectronics and Materials
Volume 15 (Special Issue) December 2022 [139-146]

Physical Properties of CdO Nano Films Deposited by Pulsed Laser Deposition Technique

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ABSTRACT

In order to create CdO TCO's films, a pulsed laser (Nd: YAG) was utilized to ablate the target of CdO in the active environment with low oxygen pressure. The optimal substrate temperature was reached in this work by using pulsed laser deposition (PLD) to build cadmium oxide (CdO) nano-films at different substrate temperatures of 200, 300, and 400°C. The CdO target was exposed to a pulsed laser with energy of 1800 mJ at a standard wavelength of 1064 nm, pulse duration of 10 ns, and ablating CdO nano-grains on quartz substrates. The XRD result shows three main planes (111), (200), and (220), and also shows increase in the intensity of the peak for the plane of (111) at the space of the atomic of 2.744Å , where the XRD results shows, an increased in the crystallization with the increased the substrate temperatures. The morphological images show the best preparation condition at 300°C that are the average grain size of roughly 82.4 nm, and surface roughness accumulated to around 1.14 nm. The morphological and structural characteristics of the prepared nano-films are tested and examined at various substrate temperatures. The findings showed that the substrate temperatures were associated with a greater crystenality.

Keyword: CdO; TCO thin film; PLD; Structural properties; low oxygen atmosphere

1. INTRODUCTION

The oxide of the Cadmium (CdO) is a kind of semiconductors with an n-type conductivity that is used in high-tech optoelectronic applications like detectors and solar cells in addition to other solid state-devices [1-4]. Oxide films made of indium, zinc, and cadmium are transparent conductive oxides with these applications [5-8]. Considering the critical importance of CdO Nano films in the fabrication and development of solid-state devices, optoelectronics devices, electro optics devices, display screens, etc. [9-13]. It is the best significant oxide with high transparency for the 2nd type to the 6th part of the semiconductors with a strong capacity for radiation absorption and emission [14-19].

It caught people's attention because of its promising qualities, including its direct and small gap ranging between (2.2 - 2.8), in addition to its high transmittance in the visible spectrum, which is crucial for solar application [20-22]. This material has all of the aforementioned characteristics in addition to being very easy to dope, abundant in nature, non-toxic, and chemically stable in hydrogen plasma [23-25]. It also has a low value in the range of resistance (from 2 - 4 cm) due to

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interstitial atoms of the cadmium and vacancy flaws of the oxygen in addition to its high melting point [26-31].

It is a cubic crystal with a center facial cubic (fcc) crystal structure, and its lattice constant is 0.4695 nm [32-34]. Many writers have looked at some of the physical characteristics of Cadmium oxide [35-39]. In the visible and near-infrared spectrums, semiconducting CdO films are transparent [40-42].

These days, this material is very intriguing because of the applications that rely on its unique electrical and optical properties, particularly in the fields of photo-diodes, solar cells, photo-transistors, transparent electrodes, gas sensors, IR detectors, liquid crystal displays, anti-reflection coatings, wear-resistant applications, low-emissivity windows, and flat panel displays [43-50].

Transparent conducting oxides (TCOs) have been deposited using a variety of thin film deposition processes, as mentioned above [51-56]. Each deposition process has certain parameters that produce films with varied characteristics since the electrical and optical transports in these films largely depend on their microstructure, stoichiometry, and kind of impurities [57-61].

2. EXPERIMENT

On cleaned quartz substrates, pulsed Nd: YAG laser deposition was used to produce thin layers of undoped CdO. A high purity cadmium target (99.999% furnished by Fluka Com.) was focused using a 12 cm focal length converging lens by Q switched Nd: YAG laser pulses with 30 ns (FWHM) and = 1.064 nm. at 45_ angle of incidence. 1 Hz was the frequency at which the target spun. At the target surface, the laser's pulse energy density was maintained at 1800 mJ. With 30 laser pulses and a substrate temperature of 523K, all films were created as presented in Figure 1.

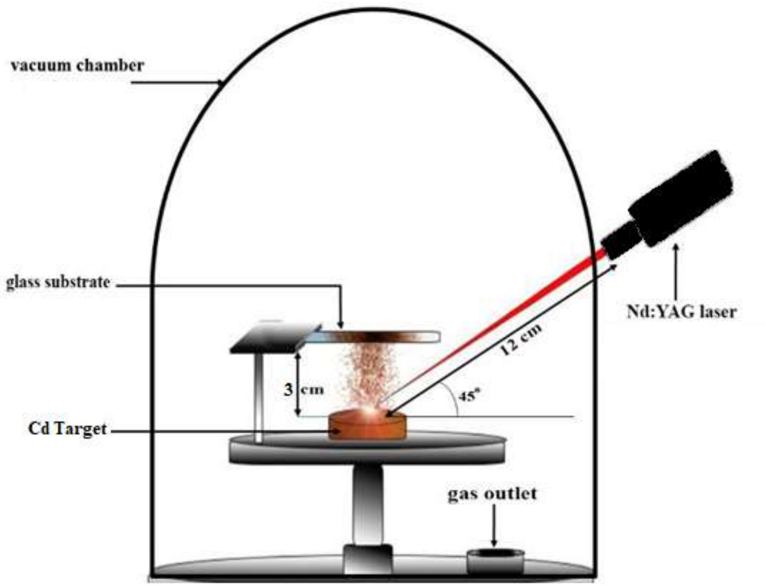


Figure 1. Schematic diagram for Pulsed Laser Deposition system.

3. RESULTS AND DISCUSSION

X-ray diffraction (XRD) was used to determine the crystallinity of the created material and was also used by another group to determine the grain size of the manufactured thin films.

The XRD pattern at the different substrates temperatures are shown in figure (2) for Zn and CdO Nano and micro-structures. We may infer from the growth circumstances that the CdO target's reflection from planes (111), (200), and (220) corresponds to the peaks that occur at 2 in the CdO spectra. When the substrate is heated, the intensity and sharpness of the diffraction peaks increase, indicating that the grains are getting bigger and the crystal quality is getting better, these results match with [62-68].

The reflections from the specified planes and the aforementioned diffraction angle provided proof that the CdO films had formed. According to Figure 2, the intensities of these peaks decreased as the substrate heated, and this was due to an increase in the relative intensity of the (111) plane at the atomic space of (2.744), which was present in the CdO/Quartz film, these results matching with [68-73].

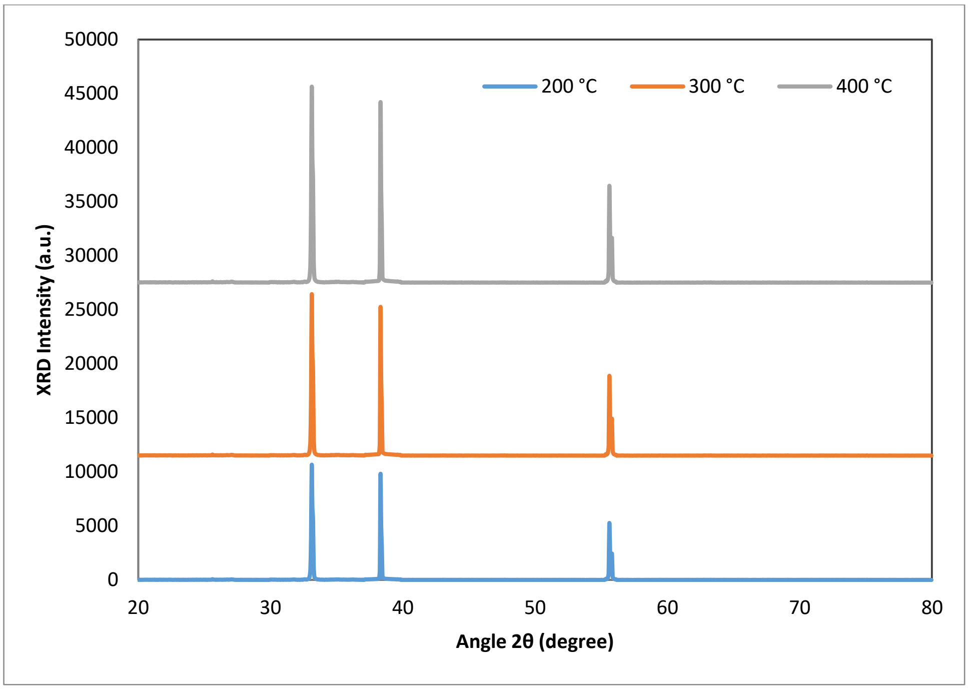
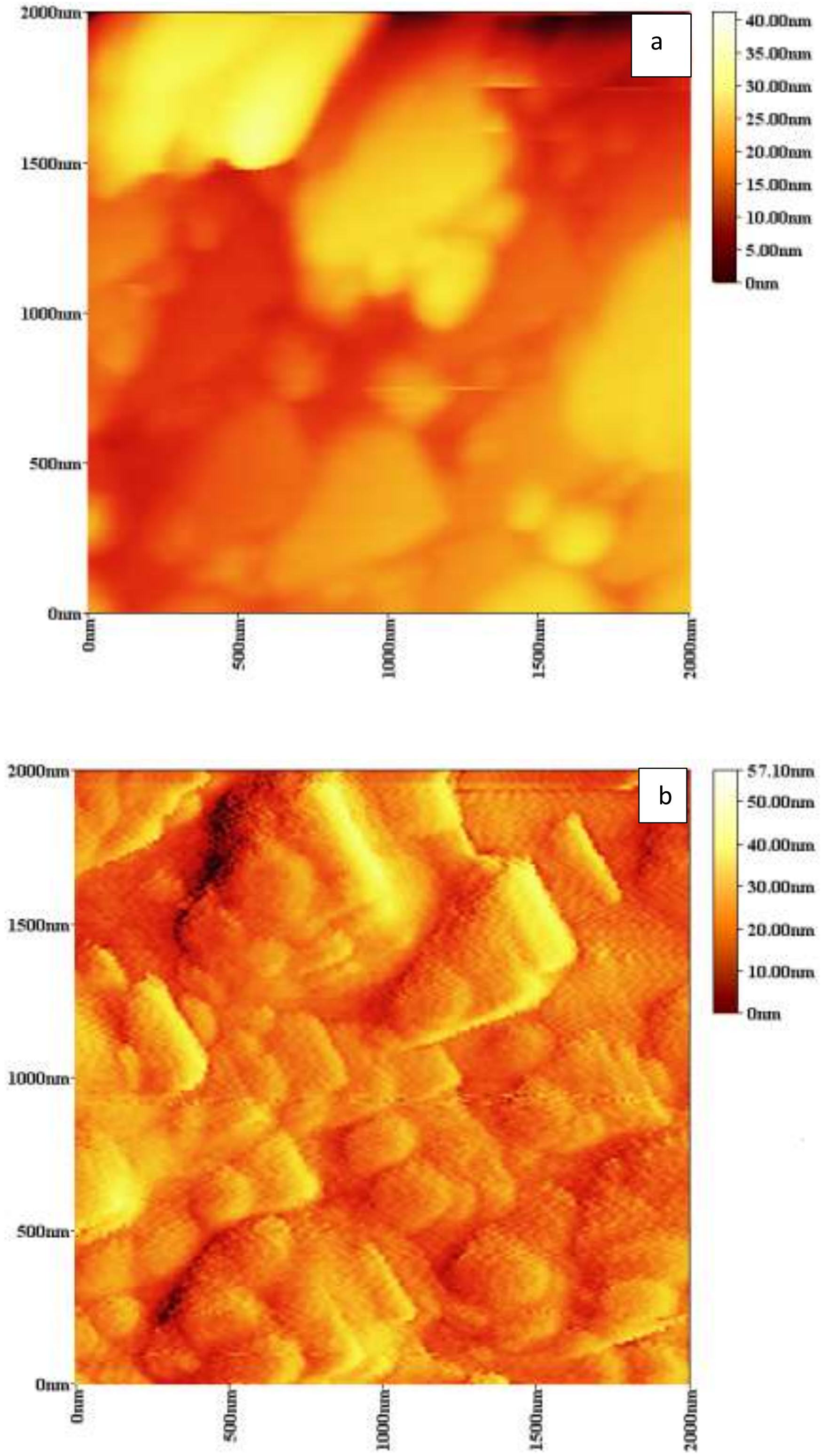


Figure 2. Pattern of XRD for deposited CdO films at different temperatures.

Figure 3 depicts the surface morphology of CdO nanostructures that have been deposited on the quartz substrates under ideal preparation conditions of 350 mbar and different substrates temperatures. Produced a very thin film made of nanoscale CdO grains with an average grain size of roughly 82.4 nm. The film slave's surface roughness accumulated to around 1.14 nm, reflecting the good quality thin membrane [74-79]. This outcome opens the door to the use of such films in electronic optical applications including the detection of thin film, solar cells, and other manufacturing. The surface survey results also showed an increase in the particle size of the precipitated films and a uniform distribution at a temperature of 300 degrees Celsius, these results matching with [80-84].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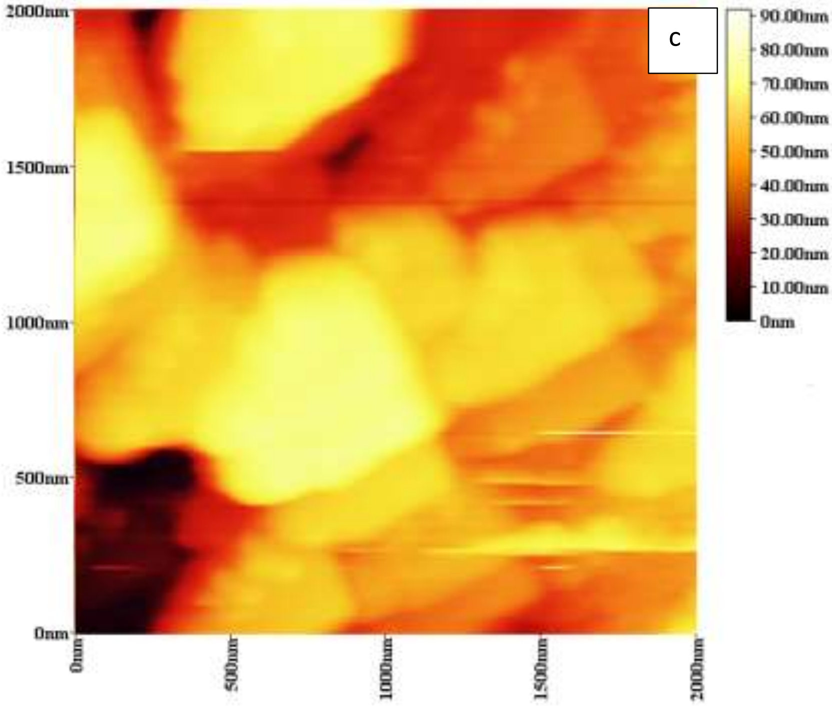

Figure 3. Surface morphology of CdO thin film deposited at various substrates temperatures a) 200 ^oC, b) 300 ^oC, and c) 400 ^oC. Please provide a higher definition photos.

4. CONCLUSION

The reactive laser deposition pulsed (PLD) process was used to successfully create the thin layer of CdO nanostructure. The produced film was applied to quartz substrates using a low-cost reactive pulsed laser deposition process at various substrate temperatures. It has been investigated how the temperature of the substrate affects the structural and morphological characteristics of depositions of CdO nanostructures. The deposited CdO's crystallinity was revealed by the XRD data increased as the substrates temperature increased. The XRD result shows an increase in the intensity of the peak for the plane of (111) at the space of the atomic of (2.744Å), and the AFM result shows the size of grains of 84 nm at 300 C and the roughness are 1.14 nm

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