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CONDENSED-MATTER SPECTROSCOPY

Structural and Optical Properties of Laser Irradiated Nano Structured Cadmium Oxide Thin Film Synthesized by Sol-Gel Spin Coating Method[1]

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Abstract—Cadmium oxide CdO nanostructured thin films are synthesized using sol-gel spin coating method. The prepared samples of CdO thin films are irradiated with 10 mJ laser from pulsed Q-Switched Nd:YAG laser at 1064 and 532 nm wavelength. The samples were exposed to 45 pulses of 7 ns pulse duration. Morphology and structural analysis were carried out with scanning electron microscope (SEM) micrographs and X-ray diffraction (XRD) patterns. Optical investigations were obtained with spectrometer and fluorospectrometer from Shimadzu. SEM micrographs confirm the nanostructure of the CdO film and indicate agglomeration of nanoparticles with laser irradiation. XRD patterns show decrease in the intensity of orientation peaks after laser irradiation. Variation in band gap energy, absorption peaks, and photoluminescence spectra with laser irradiation are observed.

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INTRODUCTION

Transparent conducting oxide (TCO) thin films have great importance in the field of microelectronics and nanoelectronics, mainly for the development of optoelectronic devices. TCOs are an essential part of technologies that require both large-area electrical contact and optical access in the visible portion of the light spectrum [1, 2]. CdO is considered as an efficient TCO thin film since CdO has a direct band gap of approximately 2.5 eV and high polycrystalline [3]. CdO films offered widely successful in many applications such as gas sensors [4], antireflection (A.R) coating, varistors [5, 6], solar cells [7], photoconductors, IR detectors, and superconducting films [8, 9]. These vast applications are recognized because the thin film structure of CdO is very sensitive to environment. Little change can affect the structural, optical, and electrical properties of CdO thin films. Their structural modifications are significantly dependent on the method of deposition as well [10–16]. CdO thin films have been synthesized using chemical bath deposition [17], radiofrequency sputtering [18], spray pyrolysis [19], pulsed laser deposition [20, 21], and sol-gel [22].

Mahdi H. Suhail et al. [23] synthesized CdO thin films using thermal evaporation technique at different substrate temperatures on glass substrates and investigated structural and optical properties. They have reported that the direct energy band gap of the deposited thin film decreases with increase of substrate temperature. R.K. Gupta et al. [24] have deposited doped CdO thin film on quartz substrate by pulsed laser deposition technique in the presence of oxygen partial pressure and reported that oxygen environment has affected the structural, optical, and electrical properties of the films. They noticed that electrical conductivity and carrier concentration decrease with increase in the oxygen pressure. A.S. Aldwayyan and his co-workers [25] have developed CdO nanoparticles from organometallic *cis*-[dmphen-CdI2] complex (dmphen = 2,9-Dimethyl-1,10-phenanthroline) through one step calcination process at 800°C and reported modification of structure and optical properties of these nanostructural CdO.

We have prepared nanostructured CdO thin films using sol-gel spin coating technique and irradiated with Nd:YAG laser at fundamental and 532 nm wavelength to investigate the effect of structural and optical properties with laser irradiation.

MATERIALS AND METHODS

Preparation of CdO Thin Film

The solution of CdO is prepared by cadmium acetate dehydrated (0.01 mol) as precursor, methanol (0.46 mol) as a solvent, glycerol (0.02 mol) and triethylamine (0.005 mol) as a stabilizer. Cadmium ace-

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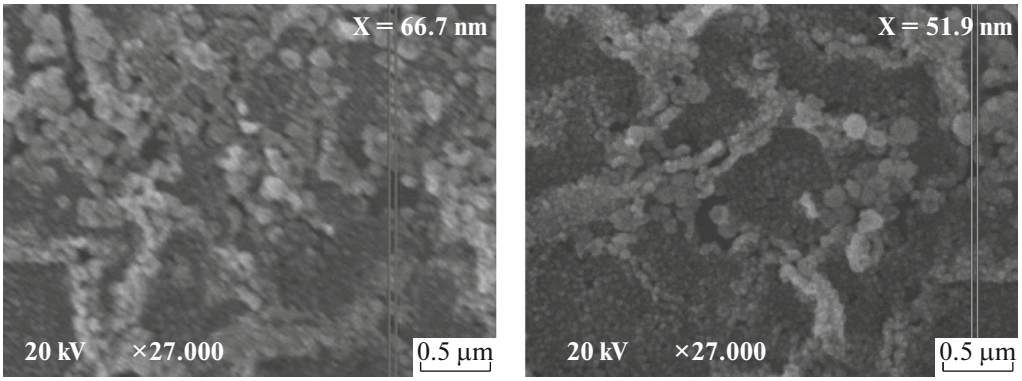

Fig. 1. SEM micrographs of CdO nanostructured thin film (without laser irradiation).

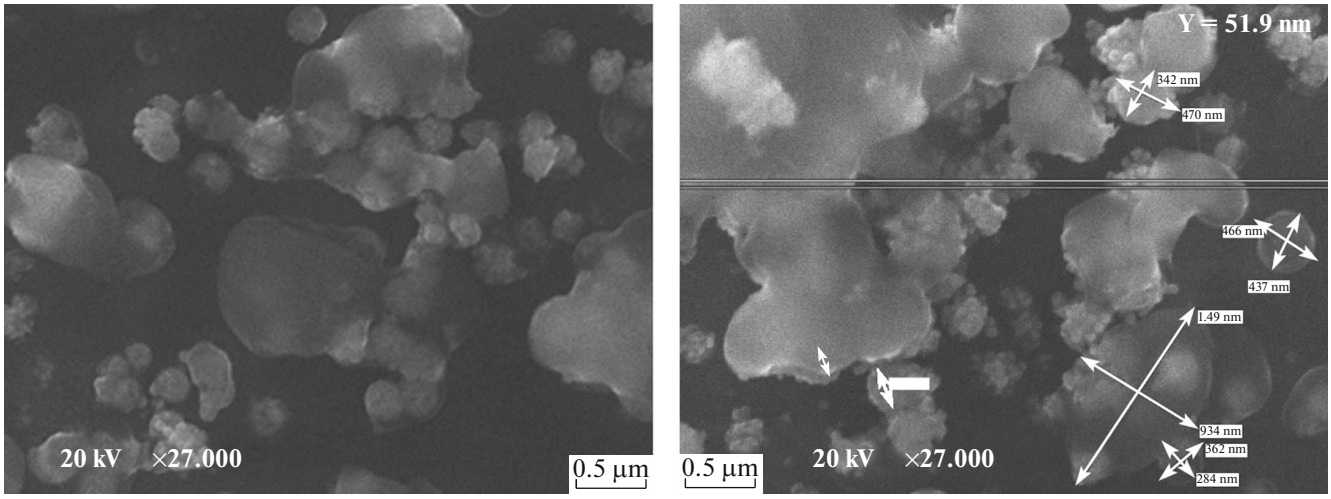

Fig. 2. SEM micrographs of CdO nanostructured thin film (with laser irradiation at 532 nm).

tate was dissolved first in half of the methanol quantity at constant magnetic stirring at 60°C until complete dissolving the Cd acetate salt in methanol and a transparent solution was obtained. Glycerol is then added to the solution. Also, the triethylamine previously dissolved in the other half of the methanol was incorporated and stirring continued at 60°C then cooling at room temperature for 22 h, in order to yield a clear and homogeneous CdO aqueous solution. The solution was used to deposit CdO thin films by sol-gel spin coating technique on clean glass substrate.

Laser Irradiation

The thin films samples of CdO were exposed to fundamental (1064 nm) and second harmonic (532 nm) of laser beam of Q-switched Nd : YAG pulsed laser (Quantel Brilliant) with 7 ns pulse width and 7 mm diameter. The samples were irradiated at 10 mJ energy per pulse with 45 shots. SEM micrograms of the samples were taken with SEM of model JSM-6380 LA. X-ray diffraction (XRD) pattern was taken using multipurpose X-ray diffractometer (Bruker, D8 Advance) with CuKα source radiation. The optical absorption of the samples was recorded at room temperature by spectrometer model 1650 PC from Shimadzu in the wavelength range of 280–850 nm. Photoluminescence measurement was recorded using JASCO spectrofluorometer (FP-8200).

RESULTS AND DISCUSSIONS

Morphology and Structural Analysis

SEM micrographs of the As deposited sample of CdO thin film were taken from two different places of the sample which are shown in Fig. 1. The micrograms confirm the nanostructure of the CdO thin film sample. SEM micrograms of the samples at two different places of the samples after laser irradiation at 532 nm wavelength are shown in Fig. 2. We can observe from