**The synthesis and characterization of spin coated ZnO and CZO films**

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***Abstract***

In this study, we report on the surface morphology of pure and Cd doped ZnO nanostructures grown by Sol- gel spin coating route a glass substrate. This film, which crystallize with a wurtzite structure preferred (002) orientation with analysis X-ray. The optical band gap was a bit changed by doping.

***Keywords***: ZnO; cadminium doping CZO;Sol-gel spin coating; XRD pattern; AFM analysis

1. ***Introduction***

Zinc oxide (ZnO) is a most studied semi-conductor material. ZnO, a wide band direct gap, belongs to the II–VI family with a band gap of 3.37 eV at room temperature and large exciton binding energy of 60 meV. It is used in different areas such as the fabrication of optoelectronic devices operating in the blue and ultra-violet (UV) region, Shottky diodes and sensors. Zinc oxide is doped with various metals such as cadmium, aluminium and tin. Further, the conditions of deposition and the choice of the substrate material are important for the film growth. Various depositions techniques have been employed for the growth process of the film. Some of them are laser deposition, electrode position and sol-gel. Here, we investigate the physical and surface properties of the pure and Cd-doped ZnO films produced by the sol-gel spin coating route onto a glass substrate.

1. ***Experimental procedure***
   1. *Filmsgrowth*

The films were grown by sol–gel spin coating route onto microscope glass slides (76 x 26) mm2 supplied by object trager Isolab. Half a mole of zinc acetate dehydrate [Zn(CH3COO)2.2(H2O)] supplied by Carlo Erba reagents  with purity of 98,5%,was dissolved in 2-Methoxy ethanol

(C3H8O2) at 10ml, and stirred at 60°C for 10min, The doping precursor, cadmium acetate dehydrate Cd (CH3COO) 2.2(H2O) supplied by Himedia with purity of 99%, was added to the solution the Mono- Ethanolamine (C2H7NO; abridged MEA) as stabilizer, was added drop by drop until the homogeneous and clear solution was obtained, then the stirring continued for 60min.The solution was then aged at ambient for one day until the gel formation. The weight of the added dopant source wascalculated as function of the desired Cd/Zn ratios, which were taken equal to 3%.

The viscous solution was homogenously poured by micro-Pipette on the substrate, sticking it on the stainless steel spin plate of a MTI, EQ-TC-100Desk-top Spin Coater [1,2,4,7]. The sample rotated for one minute at1200rpm, and then was heated under air on hot-plate at 150 1C for10min.This process was repeated 5 times, before the film was finally annealed in air at 400 °C for 60 min at the furnace.

* 1. *Films characterization*

The structural properties of Cd:ZnO (CZO) films were investigated by means of a Rigaku X-ray diffractometer with CuKα1 radiation (λ=1.5418 A1) between 20° ≤ 2 ≤ 80° . The coated films transmittance are recorded by a Shimadzu 3600PC double beam UV–VIS–NIR spectrophotometer, the morphology of surface of the simple was analysed with atomic force microscope type XEI‒ Park using a laser light and the non-contact mode NC-AFM of 256 pixel [1,3,2,4,7].

1. ***Results and discussion***

3.1. *Structural analysis*

Figure 1 shows the X-rays patterns of the pure and 3% Cd-doped ZnO thin films. The films have polycrystalline structure with a hexagonal wurtzite and the calculated lattice parameters (a and c) are given in Table 1

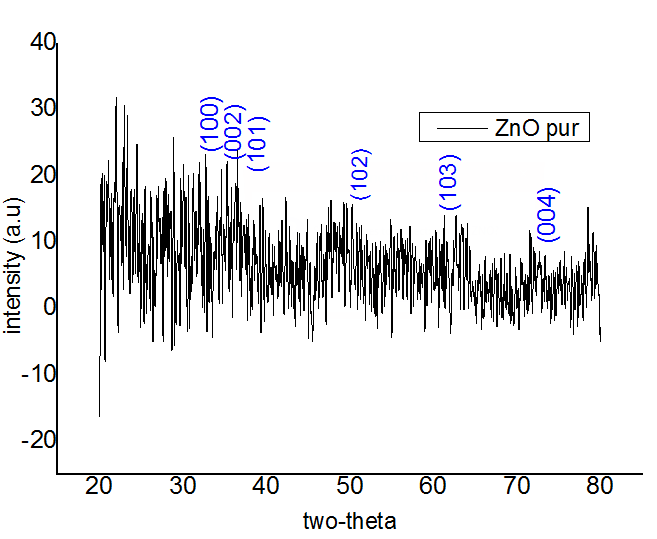
Figure 1. The X-ray pattern of pure and 3% Cd-doped ZnO thin films.

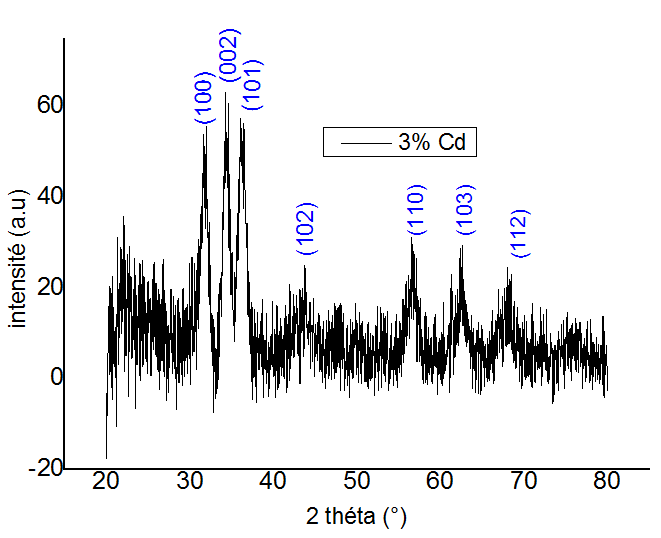
Table 1: Structural parameters of the ZnO and CZO films

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Cd/Zn**  **(%)** | **Grain size (nm)** | **Tc** | **T %**  **(550**  **nm)** | **Eg**  **(eV)** | **a (nm)** | **c (nm)** |
| 0 | 121.9 | 1.15 | 86.48 | 3.92 | 0.33 | 0.52 |
| 3 | 209 | 1.33 | 84.46 | 3.83 | 0.33 | 0.52 |

The undoped film has a random orientation with three dominant peaks of (1 0 0), (0 0 2) and (1 0 1) and the peak of (002) is the predominant [3,4,7,8,11]. When the doping level is increased, the (0 0 2) diffraction peak becomes progressively more strong. The orientation of (0 0 2) is the dominant plane in the doped films. A weak peak at (101) direction and another peak at (1 0 2), (110) were observed. These observations are in agreement with those observed by [1,2,3,4,11,10]. The grain size G of the deposited thin films are determined by using the Debye–Scherre formula [1,2] Equation 1:

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Where λ is the X-ray wavelength equal to 1.54 Å, is Bragg diffraction angle and B (radians) is the full-width at half maximum. Results of G values are given in Table 1.The Cd doping induced an increase in grain size and in the coefficient TC along [002] direction. The texture coefficient (TC), which was calculated, for the mains peaks from the X rays diffractograms. It is expressed as follows for a plane (hkl) with “Equation 2”

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when I(hkl) is the measured intensity of the plane (hkl), I0(hkl) is the ASTM standard intensity, and N is a reflection number.

*3.2 Optical characterization*

Figure 2: depicts the variation of the transmittance as a function of the incident photon wavelength of pure and 3%Cd-doped ZnO thin films. The optical transmittance is slightly improved with the dopant from 84,48% (at 550 nm) to 91,41% (at 2466 nm). Same trends are reported by M.Benhaliliba [1,2,3,4]. The average transmittance at 550nm almost equal with doping level, as listed in Table 1. The direct optical band gap (Eg) is expressed by “Equation 3”

(3)

where Eg (eV) is the optical band gap,   (m\_1) is the absorption coefficient and (Hz) is the photon frequency. We estimate the band gap Eg from the optical transmission spectra by extrapolating the linear part of the plot of ( versus to =0 it should be noted that Cd doping level has an influence on Eg as listed in Table 1. The values of optical band gap are diminished with an uncertainty of 0.09ev [9].

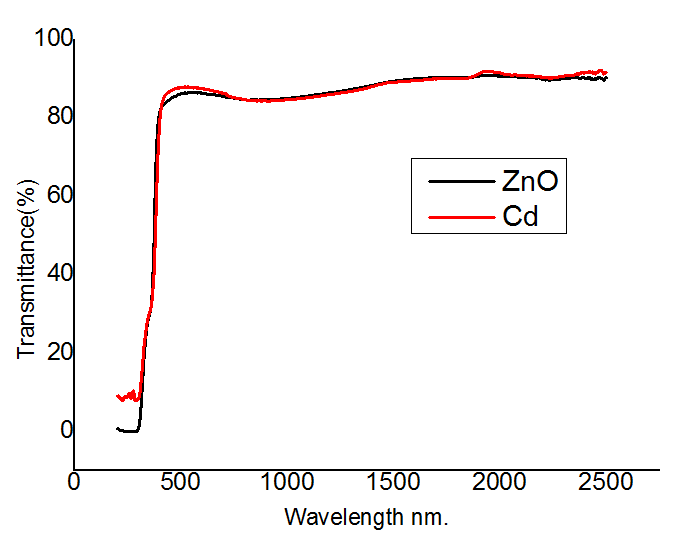
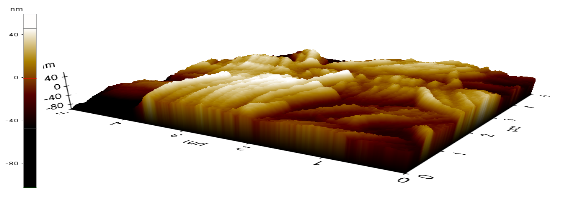
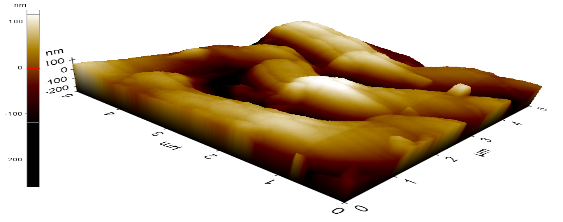


Figure 2. The variation of the transmittance as a function of the incident photon wavelength of pure and 3%Cd-doped ZnO thin films

*3.3. Surface morphology investigation*

The surface morphology and the roughness of samples are sketched in figure 3.the 3D views have dimension 5µm × 5µm. We can observe that surface of selected samples is nanofiber and become rectangular in the case of Cd-doped and the grains have a size, which sweeps in the range 18 – 42 nm.



(a)

(b)

5μm

5μm

5µm

5µm

(a)

Figure 3: (5µm x5µm) AFM scanned 3D- images of pure (a) and 3% Cd-doped (b) thin films.

***Conclusion***

The impact of cadminium doping on structural, optical, electrical and morphological properties XRD pattern reveals that coated CZO films are poly-crystalline and grow according to a preferential [002] orientation. The intensity of the main peak increases as a result of Cd content in the solution and the grain is increased due to the Cd ions incorporation in the ZnO lattice.The transmittance is slightly improved with the dopant from 84, 48% (at 550 nm) to 91, 41% (at 246 nm) and The nanofiber shape is observed in ZnO and become more rectangular in the case of Cd-doped ZnO.

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