Structural and optical characterization of ZnO layers grown by chemical bath deposition activated by means microwaves

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Abstract: - ZnO has received increasing attention and been recognized as a promising candidate for applications due to its optoelectronic properties in the UV range. The ZnO is grown by the technique of Chemical Bath Deposition activated by microwaves (CBD-μW). X-rays scattering yields a hexagonal polycrystalline wurtzite type structure. The Raman spectra present four main peaks at 444, 338, 104 and 78 cm^{-1} associated to the modes E_2^{high}, $(E_2^{high} - E_2^{low})$, E_2^{low} and an unidentified band. The 300 K photoluminescence presents visible/UV radiative bands associated to vacancies of zinc and oxygen. In addition, it was carried out energy dispersive spectroscopy (EDS) measurements on the films to determine their stoichiometry, relating the intensity of radiative bands associated to oxygen and zinc vacancies.

Key-Words: - ZnO, CBD-μW, Raman scattering, X-Ray diffraction, photoluminescence, Energy dispersive spectroscopy

1 Introduction

Zinc oxide (ZnO) is an important semiconducting oxide because it has a wide range of applications [1]. ZnO can be used in piezoelectric devices or in optoelectronic applications, especially as a transparent electrode [2, 3]. Its high electrical conductivity and optical transmittance in the visible region makes it useful for transparent conducting electrodes in flat panel displays or as optical windows in electroluminescent devices [4]. Among the various deposition techniques for ZnO thin films, DC reactive magnetron sputtering has received much attention, because of its flexibility, and because it offers good chemical composition control over extended areas. Furthermore the deposition technique offers the possibility to select the deposition rates in a wide range of values [5]. For more complex alloys, the stoichiometry of the films can be modified by changing the substrate temperature, the pressure and the reactive atmosphere used during the deposition process. Moreover the properties of the films depend too on the sputtering power and post annealing processes on the films [5,6,7].

We used the CBD technique activated with microwaves (CBD-μW). The ZnO films are grown on glass substrates. The used precursor reagents are analytic grade with purity about 99.9%.

2 Experimental details

As result of the chemical reactions in the CBD-μW the ZnO is obtained in thin film form. The solutions of the precursor reagents are prepared at room temperature using deionized water of 18.2 MΩ-cm of resistivity with the purpose of diminishing the residual impurity concentration in the material. The used molar ratios are the following: $Zn(NO_3)_2$-0.1 M, Urea-0.1, 0.2,..., 1.0 M. The samples are submerged in the solution and NH_4OH is added to it. Afterwards, they are undergoing microwave irradiation during 5 min at maximum power keeping the temperature constant and after irradiating them at lowest power for 40 min. Finally, they are rinsed with strong agitation and are dried with gaseous nitrogen.

Structural characterization of the samples is carried out by means of X-ray diffraction (XRD) in a Bruker D8 Discover diffractometer, parallel beam geometry and monochromator of gobel mirror, CuKα radiation, 1.5406 Å, in the range of $20° < 2\theta < 80°$ by step of 0.02°. The XRD data were refined using the programs POWDERX and DICVOL04 to determine the crystalline system, the parameters of unit cell and the density ρ. On the other hand the measurements of energy dispersive spectroscopy (EDS) were carried out in an LEO 438VP system, with W.D. of 26 mm using a pressure of 20 Pa to obtain the chemical