TECHNOLOGICAL ASPECT ON MORPHOLOGICAL AND ELECTRICAL PROPERTIES OF ZnO AND ZnMgO FILMS

V. Morari[1,*], V. Ciobanu[2], E. V. Rusu[1], V. V. Ursaki[2]
[1]*Institute of Electronic Engineering and Nanotechnologies „D. Ghitu", Technical University of Moldova, Chisinau, Republic of Moldova;*
[2]*National Center for Materials Study and Testing, Technical University of Moldova, Chisinau, Republic of Moldova*
[*]E-mail: vadim.morari@iien.utm.md

ZnO (zinc oxide) films are very important in a range of technological and industrial applications due to their unique physical, optical, and electronic properties. Recent studies have been carried out based on ZnO films obtained by RF magnetron sputtering and pulsed laser deposition method [1,2] for gas sensing application. The effect of deposition time on morphological and electrical properties has a crucial aspect in ZnO and ZnMgO thin films research. Crystal size and morphology can impact the electrical conductivity and optical transparency of the films [1]. It was shown that as the deposition time increases, the film thickness and crystal size of ZnO increases, the optical band gap was decreased from 3.31 to 3.29 eV, and prepared films have a quick response and fast recovery time in the range of 128 s and 163 s. Controlling the deposition time is essential for tailoring the properties of ZnO films to meet specific application requirements, whether for optoelectronic devices, sensors, or other devices (e.g., gas sensors, solar cells). Similar effects occur in ZnMgO films, where Mg incorporation can modify properties.

This paper reports on technological aspects and their impact on the morphological and electrical properties of ZnO and $Zn_{0.8}Mg_{0.2}O$ films obtained on silicon (Si) substrate using spray pyrolysis method with various deposition time, ranging from 1 min to 10 min. Our studies were carried out using atomic force microscopy (AFM) to determine the morphological parameters of the films, and electrical measurements with a Keithley multimeter (2400 Standard Series SMU) to determine the resistance of the thin films. The thickness of the obtained films was determined by scanning electron microscope (SEM) by measuring the samples in cross-section. Zinc acetate and magnesium acetate with a molar concentration of 0.25 M were used as precursors, with methyl alcohol, distilled water and acetic acid in the ratio of 6.5:2.5:1 as solvent. The substrate temperature was 480 °C and the carrier gas flow (O_2) was at a solution injection rate of 1.5 cc/min. It was found that the thickness of both ZnO and ZnMgO films increased constantly with increasing the deposition time from 50 nm (1 min) to 380 nm (10 min), while their resistance changed in a specific manner. It decreased with increasing the deposition time up to 5 min and then increased considerably, an effect that occurs for both types of oxide films (ZnO and ZnMgO). One thing to note is that the concentration of Mg in the films considerably increases the resistance of the material, so that the ZnO films resistance was of 170 kΩ at 10 minutes of deposition, while the resistance of $Zn_{0.8}Mg_{0.2}O$ films was of 420 kΩ for the same deposition time. The roughness of films varied with changing the deposition time, and the crystallites size was found to be improved with increasing the deposition time.

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