Synthesis of $Mg_xZn_{1-x}O$ thin films by spin coating and aerosol deposition methods

V. Morari[1], O. Brincoveanu[2], R. Mesterca[2], D. Balan[2], E. Rusu[1], V. Zalamai[3], M. Prodana[2], V. Ursaki[1], M. Enachescu[2]

[1]*Institute of Electronic Engineering and Nanotechnologies „D. Ghițu" of the Academy of Sciences of Moldova*
[2]*Center for Surface Science and NanoTechnology, University Politehnica of Bucharest*
[3]*Institute of Applied Physics of the Academy of Sciences of Moldova*

Ternary oxide solutions $Mg_xZn_{1-x}O$ with wide band gap are of great interest due to their potential applications in shot-wavelength optoelectronic devices based on MgZnO/ZnO heterojunctions [1,2]. In this report we present results of morphology investigation by means atomic force microscopy (AFM) and scanning electron microscopy (SEM) as well as of optical analysis by means of absorption spectroscopy in $Mg_xZn_{1-x}O$ thin films as a function of Mg concentration.

$Mg_xZn_{1-x}O$ thin films were deposited by sol-gel spin coating and aerosol deposition methods on Si (100) and silica glass substrates. Various ratios of $Mg(CH_3COO)_2 \cdot 4H_2O$ and $Zn(CH_3COO)_2 \cdot 2H_2O$ dissolved in a mixture of dimethylformamide and monoethanolamine (MEA), plying the role of solvent and stabilizer, respectively, were used for deposition procedures. The molar ratio of MEA to zinc acetate dehydrate was kept 1:1. The concentration of magnesium acetate was varied between 1 at% to 20 at%. Doping with Ga was performed by adding Ga acetylacetonate to the solution. The temperature of the substrate was maintained at 580-600^{o}C during the aerosol deposition. In the spin coating technology, the thickness of the produced thin film was controlled by the number of deposition cycles, each of them consisting from a sol-gel spin coating step performed during 20 s at a rotation speed of 2500 rpm followed by annealing of the substrate at 150^{o}C during 10 min. A number of 10 to15 cycles was applied to reach the desired thickness of the thin film. The sample was annealed at 600^{o}C for 60 min after the whole deposition procedure.

It was found from the AFM study that the surface roughness of ZnMgO films deposited by aerosol deposition method is lower than that of film produced by sol-gel spin coating (Fig. 1). The Root Mean Square roughness (RMS) parameters calculated from the acquired topographic images is around 5 nn and 12 nm, respectively. The mean size of grains at the surface of samples, determined from SEM images is around 25 nm and 50 nm, respectively.

The analysis of optical absorption spectra in the coordinates of $(\hbar\omega\alpha)^2 = f(\hbar\omega)$ revealed a direct bandgap value of around 3.75 eV for both spin coated and aerosol deposited films for a 20 at% concentration of magnesium acetate in the processing solution, which corresponds to an around 20 (mol%) of Mg in the ZnMgO solid solution according to previously published calibration curve data [3]. These data are also in line with the results of EDX analysis in our samples.

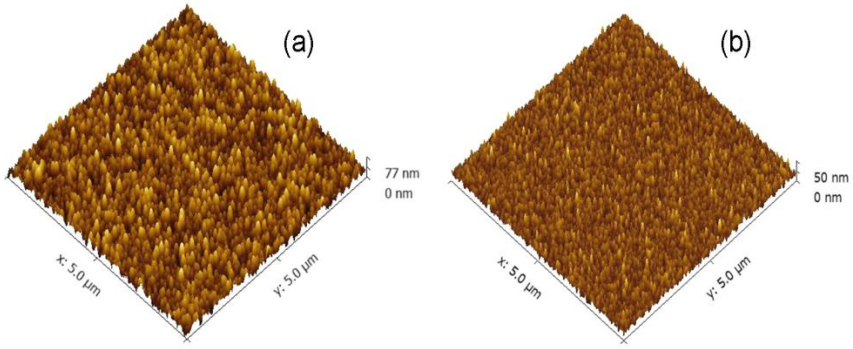

Fig. 1. AFM image of ZnMgO thin films obtained by spin coating (a) and aerosol (b) deposition methods.

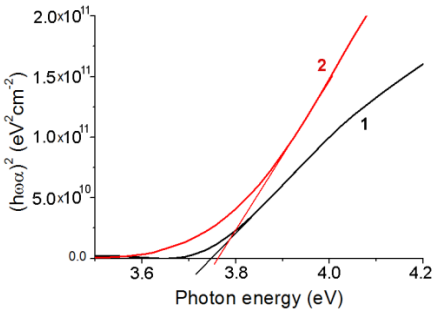

Fig. 2. Spectral dependence absorption in ZnMgO:Ga thin films at 300K.

Therefore, the results of this study suggest that the aerosol deposition is a more preferable method for the preparation of ZnMgO thin films for optoelectronic applications, as compared to spin coating.

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