Investigation of Al-doped ZnO Thin Films Deposited by Magnetron Sputtering on Si and Glass Substrates at Various Bias Voltages

A.I. Ievtushenko[1], V.A. Karpyna[1], O.I. Bykov[1], V. V. Strelchuk[2], O.F. Kolomys[2], S.V. Rarata[2,3], O.I. Olifan[1], V.A. Baturin[4], O.Y. Karpenko[4] and G.V. Lashkarev[1]

[1]I. Frantsevich Institute for Problems of Material Science, NASU, Kyiv, Ukraine,
[2]V. Lashkarev Institute of Semiconductor Physic, NASU, Kyiv, Ukraine
[3]Kyiv National Taras Shevchenko University, Kyiv, Ukraine
[4]Institute of Applied Physics, NASU, Sumy, Ukraine

Amount all transparent conductive oxides (TCO) Indium tin oxide (ITO) is more industrialized and widely-used than other ones. But the major drawbacks of ITO are a limited world reserve of indium and toxicity of its deposition technology. These drawbacks have motivated scientists to search and develop new TCO materials. ZnO is a wide band gap semiconductor material which is prospective for development of light emitting devices, ultraviolet detectors, gas sensor, especial for transparent conductive electronics. A major driving force of investigation for zinc oxide transparent conductive electronics is its widely distributed component in nature. Doped with aluminium (AZO), gallium (GZO) or indium (IZO) ZnO films are the best suited candidate to replace ITO. We believe that the development of highly efficient deposition technology for transparent conductive electrodes based on AZO films will have the commercial future.

Magnetron sputtering (MS) is the most widely used method for TCO films deposition due to good films adhesion, high deposition rates, films uniformity all over the substrates on large areas and easy control over the composition of the deposited films [1]. It is clear that the improvement of ZnO:Al films properties can be reached by the step-by-step optimization of deposition parameters. To our best knowledge, the influence of bias voltages applied to substrate (substrate bias) on the structure, optical and electrical properties of Al-doped ZnO films has not been studied yet.

The ZnO:Al thin films were deposited on Si (100), Si (111) and glass wafers using layer-by-layer growth method [1, 2] in rf magnetron sputtering of metallic composite Zn-Al target in the argon-oxygen atmosphere under the following deposition parameters: the pressure of oxygen and argon are about 0.05 and 1 Pa, respectively; 250 W of magnetron power; substrate temperature T_s = 300 $^{\circ}$C; substrate bias Us = 0 V, +2 V, –15 V, –30 V.

Therefore, our report devoted to investigation of the influence of substrate bias on structure, optical and electrical properties of ZnO:Al thin films deposited on Si (100), Si (111) and glass wafers by using layer-by-layer growth method at MS. X-ray diffraction, Raman scattering, photoluminescence, Fourier transform infrared spectrometry, optical transmission and electrical measurements were used for samples characterization. It was found that the application of negative bias voltages to wafer allow us to increase the conductivity of ZnO:Al films in three times compared to zero biased ZnO:Al films deposited at the same conditions. Obtained results will be analyzed and discussed.

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