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ZnO and ZnO:Al thin films for solar cell applications

Yegana Aliyeva*, Elnur Bagiyev, Afet Kerimova, Ayaz Bayramov

Institute of Physics ANAS, 131 H.Javid str., Az1143 Baku, Azerbaijan

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ZnO is one of the most interesting semiconducting materials with band gap energy of 3.3 eV. Due to its transparency, optimal electrical and optical properties ZnO films, doped with various impurities can be widely used as a contact electrode in thin film solar cells. In this work the results on the optimization of electrical and optical characteristics of ZnO and ZnO:Al films prepared by magnetron sputtering method are given.

ZnO and ZnO:Al thin films of about 100 nm thickness were deposited on chemically cleaned soda lime glass substrates. The deposition was performed at 200-400˚C substrate temperatures under oxygen/argon gas mixture with different O/Ar ratio (0-6%O_2). The films were characterized by X-Ray Diffraction (XRD), Photoluminescence spectroscopy, and Atomic Force Microscopy (AFM) methods.

Conductivities of ZnO:Al films deposited at 200˚C and 300˚C substrate temperatures are characterized by relatively low values and have a maximum at 2%O_2 while the conductivities of the films deposited at 400˚C are essentially higher and decrease with partial pressure of oxygen. ZnO and ZnO:Al films deposited at 200˚C in all of the range of oxygen content exhibit nearly amorphous structure. Crystallinities of ZnO:Al film deposited at 300˚C exhibit relatively low values and have a maximum at 2%O_2 while the the films deposited at 400˚C have essentially higher crystallinities which decrease with partial pressure of oxygen. The same dependences show the calculated grain sizes of the films. These results are in good agreement with conductivities of ZnO:Al. The crystallinities of ZnO films deposited at 300˚C and 400˚C are relatively lower than that ZnO:Al films which shows the essential role of Al in nucleation process during film deposition. AFM images of the films are correlated with the results on XRD measurements.

Keywords: ZnO, thin films, magnetron sputtering, crystallinity, conductivity