Stability of p-type ZnO Thin Films: Recent Progress

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The p-type transparent and conducting Zinc oxide (ZnO) thin films, in view of their potential applications in transparent electronics, are being pursued by many researchers. Nitrogen doping gives p-type, however, with extremely low hole concentration and low mobilities. The two major concerns in these p-type ZnO films are: confirmation of p-type nature by Hall measurements (because of the high resistance of the films) and the stability of the electrical and optical properties over a length of time. The earlier efforts suggest that co-doping of nitrogen and gallium seem to stabilize the p-type films. The role of gallium is mainly to pin the nitrogen. In the present study, p-ZnO thin films have been prepared on glass substrates at room temperature (300 K) by reactive magnetron sputtering technique (using nitrogen as reactive gas) employing co-sputtering of two targets: pure ZnO and Ga doped ZnO. The Gallium and nitrogen concentrations in the films have been evaluated by XPS measurements. The hole concentration and mobility in these films have been evaluated by Lake Shore Hall measurement system (Lakeshore 7604) using Quantitative Mobility Spectrum Analyser (QMSA) software. This instrument has a built-in capability to ensure the ohmic contacts to the sample. The window for both Ga and nitrogen doping to achieve p-type conductivity is observed to be very narrow. The films have been characterized for their structural, electrical and optical properties; the surface work function of these films has been measured by Kelvin probe. Electrical and optical properties on these p-ZnO have been measured periodically for 180 days and these films are found to be quite stable in their properties.

Keywords
p-ZnO
Co-Sputtering
QMSA
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Kelvin probe