PO2071

N-doped ZnO thin film deposited by reactive magnetron sputtering

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Transparent p-type conductive oxides (p-TCO) are still challenging materials in thin film deposition area. Nowadays two main families are investigated: delafossites and zinc oxides. Nevertheless some good electrical and optical results on zinc oxides doped with element from V column (N, P, As…), these materials are said to be not reproducible and not stable in time. This highlights a lack of knowledge on parameters which influence the material formation and properties. For this reason, we investigate the deposition of zinc oxide p-TCO by sputtering and its post-treatment in order to give more insight on its formation.

We first studied the N-doped ZnO deposition by reactive radiofrequency magnetron sputtering from a zinc oxide target in Ar/O2/N2 gas mixture with in-situ heated substrate holder. Analysis of film elemental composition by Rutherford Backscattering Spectrometry confirms the success of the controlled incorporation of nitrogen (1-6 at.%) and allows us to determine the best conditions for ZnO matrix stoechiometry. X-Ray diffraction shows the influence of temperature and N-incorporation on film structure, which varies from low crystallized and randomly oriented matrix to highly (002) oriented wurtzite ZnO. The phase deformation due to N-incorporation is also followed by this technique. Raman spectroscopy confirms with wurtzite ZnO structure and allows characterizing the disorder induced by N-incorporation. Finally, optical properties, especially transparency in visible range, are determined by UV-visible spectroscopy and spectroscopic ellipsometry; while electrical properties are investigated by Hall Effect measurements.

Keywords
sputtering
TCO
zinc oxide