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IMPACT OF Al CONTENT AND DOPANT ACTIVATION ON THE ELECTRICAL PROPERTIES OF REACTIVELY SPUTTERED ZnO:Al FILMS GROWN BY DIFFERENT METHODS

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AZO (ZnO:Al) is a potential candidate for transparent electrodes in electro-optic devices thanks to high transmittance in the visible region and good electronic conductivity. An optimum dopant concentration around 2 at% of Al is usually observed in Al doped ZnO films. The electronic conductivity degrades above this threshold and is commonly ascribed to the formation of Zn vacancies or precipitation of a second phase. Nevertheless, the real mechanisms involved are not clearly identified. In order to better understand this phenomenon, DC sputtering, pulsed sputtering and High Power Impulse Magnetron Sputtering (HiPIMS) were employed to deposit at room temperature high optical transparency films using a Zn/Al composite target with 2,3 and 4 at% Al. Strong electrical heterogeneities, intrinsic to the reactive sputtering process, appeared in all cases. This study reports on the relationship between the dispersion of structural and electrical properties in AZO films.

X-ray diffraction and X-ray absorption spectroscopy (XAS) at different edges were carried out to probe the influence of the synthesis method on the crystal and electronic structures of AZO films. The optical transmission was studied by UV-visible spectrometry.

While the optical transmission was very similar for all films, the electrical conductivity and optical bandgap varied with the position of the samples in the deposition chamber. The increase of c axis in the wurtzite ZnO lattice and two different coordination conformations of Al atoms support the formation of a $ZnO(Al_2O_3)_m$ homologous structure as an alternative mechanism to degrade the electronic conductivity. It was determined that the species reactivity was a fundamental factor in the deposition of very high quality AZO films as highlighted by the widening of the process window in films deposited using the HiPIMS technique.

The results are discussed in relation with the issue of aluminium activation and oxygen stoichiometry.

Keywords
TCO
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Homologous phase