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Application of Electron Backscatter Diffraction (EBSD) for Crystallographic Characterization of Aluminum-Doped Zinc Oxide Sputtered Films

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Zinc Oxide is a wide band-gap compound semiconductor [1] that has been used in optoelectronic and photovoltaic applications due to its good electrical and optical properties. Aluminium has been an efficient *n*-type dopant for ZnO to produce low resistivity films and high transparency to visible light [2]. In addition, the improvement of these properties also depends on the morphology, crystalline structure and deposition parameters. In this work, ZnO:Al films were produced by d.c. pulsed magnetron sputtering deposition from a ZnO ceramic target (2.0 wt% Al_2O_3) on glass substrates, at a temperature of 250 ºC.

The crystallographic orientation of aluminum doped zinc oxide (ZnO:Al) thin films has been studied by Electron Backscatter Diffraction (EBSD) technique. EBSD coupled with Scanning Electron Microscopy (SEM) is a powerful tool for the microstructural and crystallographic characterization of a wide range of materials [3-4].

The investigation by EBSD technique of such films presents some challenges since this analysis requires a flat and smooth surface [5]. This is a necessary condition to avoid any shadow effects during the experiments performed with high tilting conditions (70º). This is also essential to ensure a good control of the three dimensional projection of the crystalline axes on the geometrical references related to the sample [6].

Crystalline texture is described by the inverse pole figure (IPF) maps (Figure 1). Through EBSD analysis it was observed that the external surface of the film presents a strong texture on the basal plane orientation (grains highlighted in red colour). Furthermore it was possible to verify that the grain size strongly depends on the deposition time (Figure 1 (a) and (b)). The electrical and optical film properties improve with increasing of the grain size, which can be mainly, attributed to the decrease in scattering grain boundaries [6] which leads to an increasing in carrier mobility (Figure 2).

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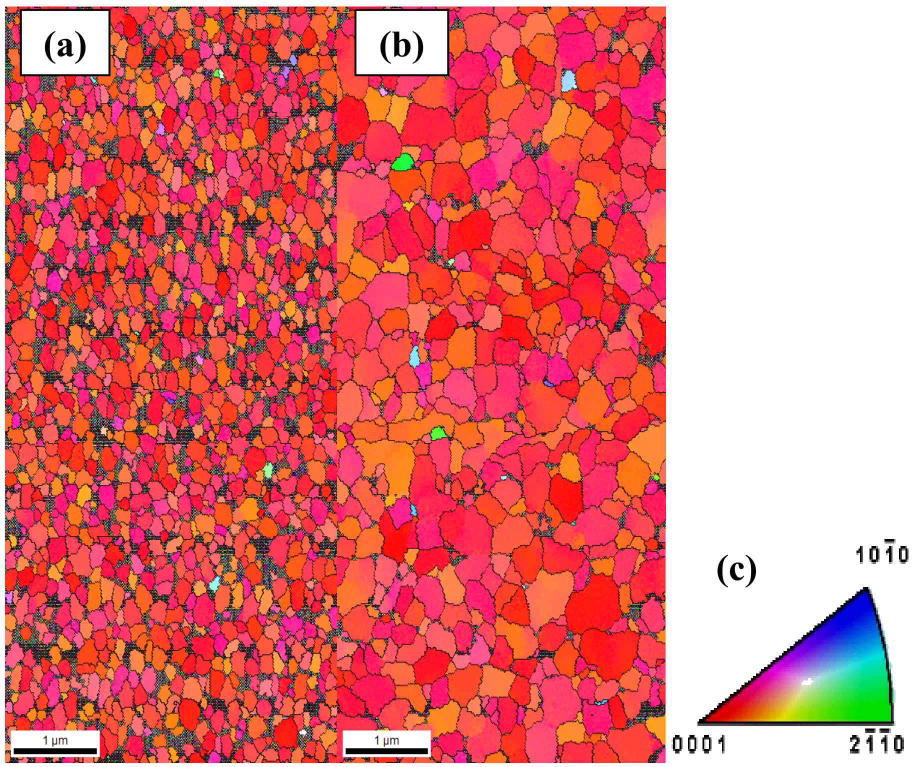

Figure 1. EBSD inverse pole figure (IPF) maps showing the [0001] preferred grain orientation relatively to the sample normal direction: (a) deposition time of 15 minutes; (b) deposition time of 60 minutes; (c) Stereographic triangle.

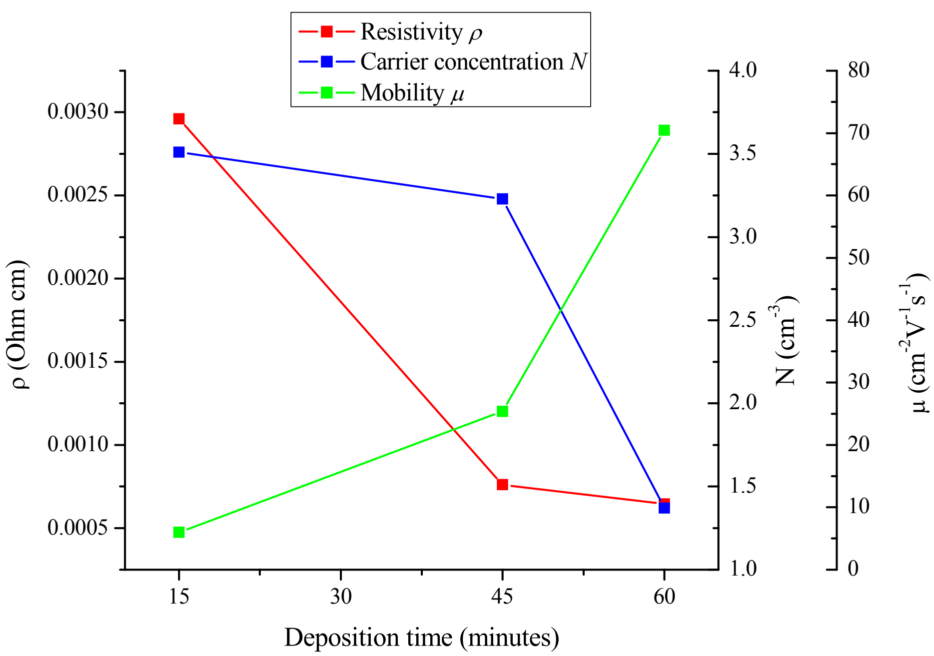

Figure 2. Resistivity ρ, carrier concentration N and mobility μ, for ZnO:Al thin films as a function of deposition time (15, 45 and 60 minutes).

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