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# Influence of Deposition Temperature and Plasma Excitation Frequency on Electronic and Structural Properties of Magnetron Sputtered Zn1-xMgxO:Al and ZnO:Al Films

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Transparent conductive oxides ($Zn_{1-x}Mg_xO$:Al ($x \approx 0.12$) and ZnO:Al thin films) were deposited by DC (pulsed) and RF (13.56 MHz and 27.12 MHz) magnetron sputtering for substrate temperatures of 25°C up to 500°C. We studied the relation between the electronic transport and structural properties for different plasma excitation frequencies and deposition temperatures. X-ray diffraction measurements revealed the crystalline quality, while conductivity and Hall measurements were used to determine the carrier concentration and Hall mobilities, respectively.
For the films deposited at 13.56 MHz, recent measurements[1] showed a resistivity minimum for a deposition temperature of $T_{sub} \approx 300$°C. This minimum is accompanied by the highest concentration and Hall mobility of the carriers. The crystalline quality and carrier concentration was mainly influenced by the bombardment of the growing film with high energetic negative oxygen ions for lower deposition temperatures and by phase segregation for higher deposition temperatures. The dependence of the effective mobility of the carriers on the temperature and the material used was explained with the help of a combined transport model taking into account ionized impurity scattering and grain barrier limited transport. For the films deposited with DC or 27.12 MHz plasma excitation frequency, a minimum for the resistivity is observed as well. The minimum obtainable resistivity is decreasing with increasing plasma excitation frequency. This can be explained as a result of the reduced maximum energy of the high energetic negative oxygen ions, which is due to a decreasing target voltage with increasing plasma excitation frequency.
References:
1. A. Bikowski and K. Ellmer. *J Mater Res*, in press (2012).

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