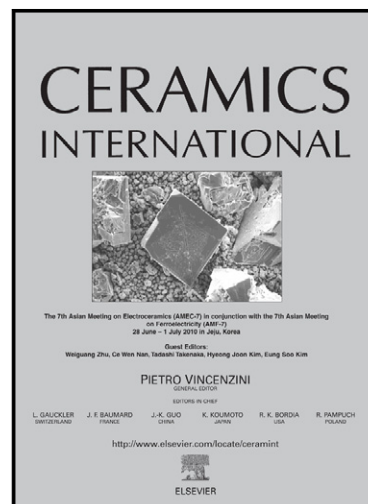


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Role of annealing temperature on electrical and optical properties of Al-doped ZnO thin films

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Abstract

Undoped ZnO and Al-doped ZnO (AZO) thin films 200 nm thick were grown on polished and fused silica (SiO₂) substrates by room temperature RF magnetron sputtering. High-purity ZnO (99.99 %) and Al (99.999 %) target materials were used. The samples were annealed at 300 °C, 400 °C, and 500 °C for 45 min in N₂ ambient gas. The effects of the annealing temperature on crystal structure, optical properties, and resistivity of the AZO thin films were systematically explored. As grown samples exhibit single crystalline Würtzite structure with preferred orientation along c axis from substrate surface. The crystal quality decreases with increasing amount of Al concentration. Annealing process increases the long range crystal order of films. Optical transmittance measurements show that all samples annealed at 500 °C have average 80 % transparency in the visible light. Optical band gap values range between 3.23 eV to 3.72 eV for as grown and annealed samples. The electric conductivity of the AZO films increases with increasing Al concentration. The annealing process especially at 400 °C provides the best conductivity due to the improved crystal structure and carrier concentration of films. The minimum resistivity value of $9.40 \times 10^{-5} \Omega \text{cm}$ was measured for the Al_{12.30}ZnO film after annealing. The mobility decreases due to increase in grain boundary scattering.

Keywords: Al-doped ZnO; RF Magnetron sputtering; Optical and electrical properties

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