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# Al-doped ZnO Thin Films Grown by Pulsed Laser Deposition Technique: Effect of Substrate Crystallinity on Thermoelectric Performance

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We have prepared 2% Al doped ZnO (AZO) thin films on amorphous substrates (fused silica (FS)) and single crystal substrates ($SrTiO_3$) by Pulsed Laser Deposition (PLD) technique at deposition temperature of 400ºC. Deposition parameters such as pulse frequency (10 Hz), substrate-target distance about (35 mm) and rotation speed of the target (30% rpm) were kept unchanged during all the deposition routines.

Electric conductivity (σ) and Seebeck coefficient (S) were evaluated in the interval T = 300 - 600 K. σ was found lower for FS, while S is always negative, confirming n-type conduction, and its absolute value was higher for the thin film deposited on FS than on STO. The best performance was obtained with thin film deposited on FS, which is c-axis oriented and presents columnar growth: σ = 74 S/cm, S = -119 μV/K, and power factor ($S^2\sigma$) = $0.11\times10^{-3}$ $Wm^{-1}K^{-2}$ at 300 K. Its thermal conductivity (κ) at room temperature ($\kappa_{300K}$) is 4.89 $Wm^{-1}K^{-1}$, an order lower than for the corresponding bulk material of same composition (34 $Wm^{-1}K^{-1}$).

ZT = ($S^2\sigma$)T/κ (figure of merit) at elevated temperatures are estimated using ($\kappa_{300K}$) with a conservative approach. ZT of AZO film on FS is about 0.05 at 600 K, surpassing the performance of bulk material and of film on single crystal (fig 1). Since silica is cheaper than crystalline substrates, this result is quite promising for practical applications of thermoelectric oxide thin films.

**Keywords:** Thermoelectric, Oxide thin films, Pulsed Laser Deposition, Seebeck coefficient, Power factor

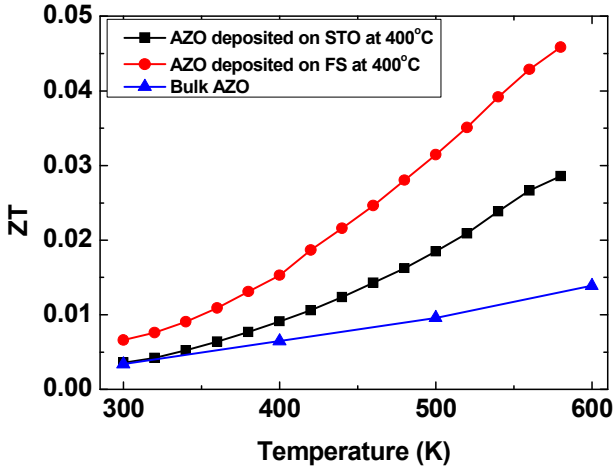


Fig 1: Dimensionless figure of merit ZT for AZO thin films deposited on an amorphous substrate (fused silica (FS)) and a single crystal substrate ($SrTiO_3$) at 400ºC along with bulk material of same composition.