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PII: S0040-6090(15)01173-6
DOI: doi: 10.1016/j.tsf.2015.11.053
Reference: TSF 34835

To appear in: *Thin Solid Films*

Received date: 30 April 2015
Revised date: 18 November 2015
Accepted date: 20 November 2015

Please cite this article as: M.J. Rivera, E.B. Ramírez, B. Juárez, J. González, J.M. García-León, L. Escobar-Alarcón, J.C. Alonso, Low temperature-pyrosol-deposition of aluminum-doped zinc oxide thin films for transparent conducting contacts, *Thin Solid Films* (2015), doi: 10.1016/j.tsf.2015.11.053

Low temperature-pyrosol-deposition of aluminum-doped zinc oxide thin films for transparent conducting contacts

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Abstract

Aluminum doped-zinc oxide (ZnO:Al) thin films with thickness ~1000 nm have been deposited by the ultrasonic spray pyrolysis technique using low substrate temperatures in the range from 285 to 360 °C. The electrical and optical properties of the ZnO:Al (AZO) films were investigated by Uv-vis spectroscopy and Hall effect measurements. The crystallinity and morphology of the films were analyzed using X-ray diffraction (XRD), atomic force microscopy (AFM), and high resolution scanning electron microcopy (SEM). XRD results reveal that all the films are nanocrystalline with a hexagonal wurtzite structure with a preferential orientation in the (002) plane. The size of the grains calculated from Scherer´s formula were in the range from 28 to 35 nm. AFM and SEM analysis reveals that the grains form round and hexagonal shaped aggregates at high deposition temperatures and larger rice shaped aggregates at low temperatures. All the films have a high optical transparency (~82 %). According to the Hall measurements the AZO films deposited at 360 and 340 °C had resistivities of 2.2 x 10^{-3} - 4.3 x 10^{-3} Ω cm, respectively. These films were