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Nanostructured Fluorine Doped Zinc Oxide Thin Films Deposited by Ultrasonic Spray Pyrolisys Technique: Effect of Starting Solution Composition and Substrate Temperature on the Physical Characteristics

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Abstract : The doping it is believed as follows, at high concentration fluorine in ZnO: F films is incorporated to the lattice by substitution of O-2 ions by F-1 ions; at middle fluorine concentrations, F ions may form interstitials, whereas for low concentrations it is increased the carriers and mobility could be explained by the surface passivation effect of fluorine. ZnO:F thin films were deposited on sodocalcic glass substratesat 425 °C , 450°C, 475 during 8, 12, 15 min from a 0.2 M solution. Doping concentration in the starting solutions was varied, namely, [F]/[F+Zn] = 0, 5, 15, 30, 45, 60, and 90 at. %; solvent composition was varied as well, 100:100; 50:50; 100:50(acetic acid: water: methanol ratios, in volume). In this work it is reported the characterization results of fluorine doped zinc oxide (ZnO:F) thin films deposited by the ultrasonic spray pyrolysis technique, using zinc acetate and ammonium fluorine as Zn an F precursors, respectively. The effect of varying the fluorine concentration in the starting solutions, the solvent composition, and the ageing time of the starting solutions, on the electrical resistivity, optical transmittance, structure and surface morphology was analyzed. In order to have a quantitative evaluation of the ZnO:F thin films for its application as transparent electrodes, the Figure of Merit was estimated from the Haacke´s formula. After a thoroughly study, it can be found that optimal conditions for the deposition of transparent and conductive ZnO:F thin films on sodocalcic substrates, were as follows; substrate temperature: solution molar concentration 0.2, doping concentration in the starting solution of [F]/[Zn]= 60 at. %, (water content)/(acetic acid) in starting solution: [H2O/ CH3OH]= 50:50, substrate temperature: 450 °C. The effects of aging of the starting solution has also been analyzed thoroughly and it has been found a dramatic effect on the electric resistivity of the material, aged by 40 days, show an electrical resitivity as low as 120 Ω/□, with a transmittance around 80% in the visible range. X-ray diffraction spectra show a polycrystalline of ZnO (wurtzite structure) where the amount of fluorine doping affects to preferential orientation (002 plane). Therefore, F introduction in lattice is by the substitution of O-2 ions by F-1 ions. The results show that ZnO:F thin films are potentially adequate for application as transparent conductive oxide in thin film solar cells.

Keywords : TCOs, transparent electrodes, ultrasonic spray pyrolysis, zinc oxide, ZnO:F
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