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CUPROUS OXIDE/CADMIUM STANNATE HETEROJUNCTION DIODES OBTAINED BY DIP-COATING METHOD

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ABSTRACT

The fabrication of p-n heterojunction diodes using semiconducting metal-oxides obtained from a solution-based method was investigated. Initially, n-type transparent cadmium stannate (Cd_2SnO_4) conducting films were deposited by the dip-coating method on glass substrates. The films were sintered in air for 1 h at 550 ℃ and annealed in vacuum for 10 min at 550 ℃. A low resistivity value was obtained ($\rho \approx 2 \times 10^{-3}$ Ω-cm) for films with average thickness of ~ 380 nm. For the p-type layer, cupric oxide (CuO) was deposited using the dip-coating method over the transparent conductive oxide. Several layers were deposited and a drying process in air was applied at 250 ℃ for each coating. CuO thickness (τ) was in the 49-270 nm range as the number of coats varied from 5 to 14. After that, the samples were subjected to a rapid thermal annealing treatment (RTA) in vacuum during 10 min at a temperature T_A, within the 300℃ ≤ T_A ≤ 450℃ range, depending on τ, to reduce the CuO phase into the cuprous oxide (Cu_2O) phase. Cu_2O has shown a better crystalline quality and lower resistivity than CuO, obtaining a more efficient charge transport. From the X-ray diffraction patterns obtained from the heterojunction, the presence of Cd_2SnO_4 is confirmed. The CuO layer after RTA treatment shows three different types of films, depending on both T_A and τ: i) CuO (amorphous)+Cu_2O, ii) Cu_2O and iii) Cu_2O+Cu. Specular reflectance measurements were performed to show the presence of amorphous CuO and to confirm the full transformation from CuO to Cu_2O.Current-voltage measurements were performed using silver paste on Cd_2SnO_4 and a graphite probe on the copper oxide layer, as ohmic contacts. All heterojunctions with a copper oxide layer of ~ 49 nm, show an ohmic behavior. For higher τ, independent of the type of copper oxide film, a rectifying behavior is shown, which improves as τ increases and only the Cu_2O phase is obtained. Best rectification is achieved in samples with ~ 270 nm of Cu_2O at T_A = 425 ℃. In this work, as far as we know, for first time Cu_2O/Cd_2SnO_4 diodes were fabricated using the dip-coating method. The electrical parameters for the best rectification were: ideality factor (n = 4.8), saturation current density ($J_0 = 3.20 \times 10^{-5}$ A/cm^2) and turn-on voltage (V_{to} = 1.1 V).