Abstract

Different thin films samples made of SnO2, F:SnO2, Pd: SnO2 and and co-doped Pd-F: SnO2 were deposited at a substrate temperature of 450oC using optimized doping concentrations of F and Pd, thereafter the samples were annealed and passivated in a tube furnace at 450oC. Optical and electrical methods were used in characterizing the thin film samples: The band gap energy for all samples was extracted from optical data using a proprietary software, Scout™ 98. The calculated band gap energy were found to be 4.1135eV for Pd:SnO2 and 3.8014eV for F:SnO2 being the highest and the lowest calculated band gap energies, respectively. The wide band gap energy has been attributed to the incorporation of Pd ions in crystal lattice of SnO2 thin film for Pd:SnO2 while for F:SnO2 has been due to incorporation of F- ions in the crystal lattice of SnO2 which gives rise to donor levels in the SnO2 band gap. This causes the conduction band to lengthen resulting to a reduction in the band gap energy value. The electrical resistivity was done by measuring the sheet resistance of the SnO2, Pd:SnO2, F:SnO2 and Pd-F:SnO2 thin films. The undoped SnO2 thin film had the highest sheet resistivity of 0.5992 Ωcm while F:SnO2 had the lowest sheet resistivity of 0.0075 Ωcm. The low resistivity of F:SnO2 results from substitution incorporation of F- ions in the crystal lattice of SnO2 thin films, instead of O- ions which lead to an increase in free carrier concentration. The Pd-F:SnO2 gas sensor device was tested for CO2 gas sensing ability using a lab assembled gas sensing unit. The performance of the gas sensor device was observed that: the as prepared device was more sensitive to CO2 gas than those subjected to annealing and passivation. The decrease in the sensitivity of the annealed Pd-F: SnO2 gas sensor is attributed to decrease in grain boundary potential resulting from grain growth. This causes a decrement in adsorption properties of CO- and O- species by the annealed Pd-F: SnO2 thin film. The sensitivity of passivated Pd-F: SnO2 gas sensor was found to be the lowest. The low sensitivity is due to the effects of nitration and decrement in grain boundary potential resulting from grain growth, nevertheless, the sensitivity of the passivated Pd-F: SnO2 thin film was found to be within the range for gas sensing applications.