Effect of Oxygen Flow Rate in Zinc Oxide Radio Frequency Magnetron Sputtering on the Structural and Optical Properties of ZnO/PEDOT : PSS Inorganic|Organic Hetero-junction

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Highly transparent ZnO/PEDOT : PSS inorganic|organic hetero-junction were fabricated using thin (300 nm in thickness) ZnO prepared via radio frequency (RF) magnetron sputtering at different oxygen flow rates ranging from 0 to 20 sccm. The AFM images revealed that the average grain size decreased with increasing oxygen flow rate. In addition, the results of this analysis showed that with an increase in the oxygen flow rate, the average and RMS of surface roughness decreased. The energy gap measured for the zinc oxide layers deposited in the presence of oxygen with flow rates of 0, 5, 10, 15, and 20 sccm remained nearly constant at the value of 3.17 ± 0.01 eV indicating that the energy gap of ZnO layer was relatively independent of the Ar/O_2 flow rate. In order to investigate the junction between zinc oxide and poly(3,4-ethylenedioxythiophene) polystyrene sulfonate (PEDOT : PSS), a 50-nm thick polymeric layer is deposited on a 300-nm zinc oxide layer by spin coating technique. The dark $I(V)$ characteristics indicate that the reverse saturation current density is $2.89 \cdot 10^{-7}$, $1.27 \cdot 10^{-7}$, $1.96 \cdot 10^{-7}$, $3.89 \cdot 10^{-7}$, and $4.41 \cdot 10^{-7}$ A/cm^2 for oxygen flow rates of 0, 5, 10, 15, and 20 sccm, respectively. By increasing the oxygen flow rate, the ideality factor of the resulting Schottky barrier is 2.79, 1.96, 2.32, 2.96, and 3.03. The effective Schottky barrier height of 0.78, 0.8, 0.79, 0.77, and 0.76 eV was obtained for oxygen flow rates of 0, 5, 10, 15, and 20 sccm, respectively. It was found that the highest responsivity and the sensitivity obtained from UV-photocurrent of the nanostructures is for the samples deposited at oxygen flow rates between 5 to 10 sccm.

Keywords: hetero-junction, oxygen, PEDOT:PSS, zinc oxide, Schottky barrier.

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