ABSTRACT

Zinc oxide (ZnO) is one of the most important II-VI semiconductor that has drawn a significant attention worldwide due to its remarkable properties and potential applications in various fields. In this work, ZnO thin films were deposited on different substrates including polyethylene terephthalate (PET), silicon and glass by direct current (DC) reactive magnetron sputtering at different Ar:O_2 gas ratio and a comparative study on the film's physical properties was conducted. The results showed a better crystallinity of the c-axis ZnO film on PET and silicon as compared to the glass. The electrical resistivity of the film on the silicon was the lowest one (1.9×10^{2} Ω-cm) whereas the minimum band gap of ZnO (3.23 eV) was obtained on the PET substrate. The films with optimized structural, electrical and optical properties were used for the ion implantation study. The transition metal ions such as copper, cobalt and nickel were implanted in the ZnO (M: ZnO) by Pelletron Accelerator at different doses of 1×10^{11}, 1×10^{12}, 1×10^{13}, and 1×10^{14} ions/cm^2 at room temperature by keeping the ion energy constant at 300 keV. The results of copper ion implanted ZnO film showed a decrease in its crystallite size up to the dose of 1×10^{12} ions/cm^2, and then it was increased with further increase of the ion dose. The lattice parameter of ZnO was decreased after the copper ion implantation at different doses that was ascribed to the lower ionic radius of Cu^{+} as compared to the Zn^{+2}. The lowest values of band gap and resistivity were obtained at the ion dose of 1×10^{14} ions/cm^2. The cobalt ion implantation showed similar types of changes in the structural, optical and electrical characteristics of the ZnO film. However, in the case of silver ion implantation, significant structural damage was done in ZnO film which is due to its high atomic number as compared to cobalt and copper. Afterwards, the copper ion implanted film of optimum properties was used for the fabrication of a metal-semiconductor-metal (MSM) photodetector. The responsivity of the device was found to be 941 mA/W under 385 nm UV light exposure at 7V. The analysis of photodetection results suggested the formation of highly responsive photodetector based on the copper ion implanted ZnO film on a flexible substrate.