

ABSTRACT

Zinc oxide (ZnO) is a remarkable material due to its good inherent properties so can be employed in various electronic and optoelectronic devices. The ZnO properties for advanced optoelectronic applications can be altered by doping a suitable element in it. This study elucidates changes in the properties of ZnO films by implanting nickel ions (Ni^+) at different fluences. The target of pure zinc was magnetron sputtered in Ar- O_2 (80:20 ratio) at room temperature (RT) to grow ZnO film on p-type silicon. The films were implanted with Ni^+ of energy 300 keV by using Pelletron Accelerator. Ion implantation in films was performed for 1 min, 10 min, 30 min and 60 min and the corresponding fluences for these durations were 1.8×10^{12} , 1.8×10^{13} , 5.6×10^{13} and 1.1×10^{14} ions/cm² respectively. The ion range of nickel in the films was about 181nm obtained via SRIM software. Structural analysis of as-deposited and ion-implanted films was performed using x-ray diffraction (XRD) technique. The XRD results revealed that by increasing the ion-fluence, the c-axis lattice parameter of ZnO was decreased. Initially, the Ni^+ implantation resulted in amorphization of the film, however, the film's crystallinity was improved at 1.1×10^{14} ions/cm². The results of FESEM showed bean-shaped granular structure of ZnO that became more prominent and isolated at lower ion fluence (1.8×10^{13} ions/cm²). The results of UV-visible reflectance spectroscopy revealed an increase in the film's band gap from 3.37 eV to 3.49 eV after ion implantation up to 1.8×10^{13} ions/cm², attributed to Burstien-Moss shift (due to structural defects as well as the donor behavior of nickel ions). However, the band gap was decreased with further increase of the ion fluence relating to improvement in the film's crystallinity. The electrical resistivity, measured using four probe method, was decreased from 952 to 68 Ω -cm with increasing the ion fluence up to 5.6×10^{13} ions/cm² due to the creation of oxygen vacancies. However, a significant increase in the resistivity of ZnO film was noticed with further increase in the ion fluence.