ABSTRACT

In this work, effect of annealing temperature on the photodetection characteristics of the copper oxide film has been examined. The copper oxide film was grown on p-type silicon substrate by DC magnetron sputtering system. After deposition, the film was annealed at 400 °C and 500 °C for two hours. Before the investigation of photodetection characteristics of the copper oxide, structural, morphological and optical characterizations of the film was made by using x-ray diffraction (XRD), field emission scanning electron microscope (FESEM) and UV-visible spectroscopy respectively. The structural results revealed only a single diffraction peak of CuO corresponding to (-111) plane, revealing its monoclinic structure. The FESEM results indicated an increase in the grain size from 25 to 42 nm with increase of the annealing temperature to 500 °C. The band gap of the copper oxide film annealed at 500 °C was found to be 2.63 eV. For the study of photodetection characteristics, aluminum (Al) contacts were made on the films by RF sputtering technique using a metal mask. The photodetection characteristics of the as deposited and annealed films were studied at 10 V under the exposure of visible light of different intensities. The current-voltage characteristics of the Al/CuO/Al device showed formation of Schottky contact between the Al and CuO film, owing to lower work function of Al (4.1 eV) than that of the p-type CuO semiconductor (4.7 eV). The photocurrent of the device was considerably increased after the film's annealing under 58.4 $\mu W/cm^2$ visible light exposure at 10 V bias. The photocurrent was also increased with the increase of incident light intensity from 58.4 $\mu W/cm^2$ to 511 $\mu W/cm^2$. The improvement in the photocurrent of the Al/CuO/Al device after annealing was attributed to the reduction in structural defects that acted as trapping centers/barriers to the motion of free charge carriers. Similarly, with the increase of light intensity, the increase in photocurrent was ascribed to the generation of more free charge carriers (electrons and holes) by the increased number of photons. The current gain, sensitivity, rise time and fall time values for the CuO based photodetector before and after annealing were calculated from the current-time graphs. The current gain and sensitivity were increased with increase of the annealing temperature to 500 °C. The maximum current gain and sensitivity values were found as 66 and 7086.8% respectively