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Abstract
Copper oxide coating is known to show p-type conductivity and as a consequence, it is attracting increasing attention. CuO is a p-type semiconductor with a band gap of 1.2-1.9 eV and a monoclinic structure. The development of p-type semiconductor is one of the key technologies for p-n junction based devices, such as diodes, transistors and light-emitting diodes.
Nanocrystalline copper oxide films have been synthesized on glass by dc magnetron sputtering. The effects of oxygen flow rate, deposition temperature and sputtering power on the microstructure of nanocrystalline copper oxide films were investigated by X-ray diffraction and FE-SEM. X-ray diffraction analysis shows that a peak of CuO (111) was observed at the deposition condition of DC power 150W, pressure 3.3Pa, substrate temperature 200℃, Argon flow rate 15 sccm and O2 flow rate 4.5sccm. SEM pictures show that copper oxide films exhibit nanosize grains. X-ray diffraction patterns of CuO films deposited at RT.~300℃ show that only (111) plane is obtained. The SEM pictures show that the grain size increases with the deposition temperatures increases. The grain size of CuO thin films are around 50-200nm. The hole concentration and mobility at 200℃ and 300℃ were both 1016 cm-3 and 0.8 cm2/V・S observed by Hall-effect measurement, respectively. The resistivity of CuO film was around 400Ω-cm at room temperature. The higher mobility of CuO at 100W was 50cm2/V・S. The absorption wavelength of CuO thin films showed “red shift” with changed substrate temperatures and oxygen flow rate. The energy band gap of CuO thin films were 1.6-1.95.
The hole concentration of CuO thin films was increased to 1017cm-3 after annealing in a nitrogen atmosphere. The resistivity of CuO thin films annealed at 300℃ decreased to 60Ω-cm. The energy band gap of CuO thin films annealed at 300℃ were no changed. In the I-V measurement analysis, two kinds of herterostructures, p-CuO/n-ITO and p-CuO/i-ZnO/n-ITO were used. The turn on voltage of two herterostructures were around 0.1~0.5V. The I-V measurement of two herterostructures showed a diode characteristic.
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