Annealing effects of the sulfur treated n-type and p-type cuprous oxide

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Cu_2O semiconductors have several interesting properties to be used in solid state device applications. The high resistivity and defects of Cu_2O have hindered the reliability and performance of resulting Cu_2O based devices and, there are hardly any reports on their practical applications due to the difficulty in controlling the electrical and optical properties of them. For device applications, understanding surface behavior is also important , because surface passivation is a crucial processing step in the fabrication of electronic and optoelectronic devices. Our recent work [1-2] demonstrates that the passivation of electrodeposited p-Cu_2O and n-Cu_2O thin films using ammonium sulfide which lowers the resistivity while increasing photoactivity.

In this study, the n-type and p-type cuprous oxide films were electrodeposited potentiostaticaly on Ti substrate in acetate and lactate baths respectively. For surface passivation of the deposited Cu_2O films, the film surfaces were exposed to ammonium sulfide gas. All Cu_2O thin films were investigated in a three electrode photoelectrochemical cell containing a 0.1 M sodium acetate solution, in order to make the photoresponse measurements. After sulfur passivation, Cu_2O films were annealed in air at 100 °C, 150 °C, 200 °C, 250 °C, 350 °C and 450 °C. Figure 1 shows the spectral response of the n-type and p-type Cu_2O film. The negative photoresponse corresponding to the p-type and positive photoresponse corresponding to n-type Cu_2O. Optimum annealing temperature for highest photocurrent was found to be 200 ^{0}C for both n-type and p-type Cu_2O on Ti substrate. Optimum results revealed that the annealing of Cu_2O samples improves the peak photocurrent

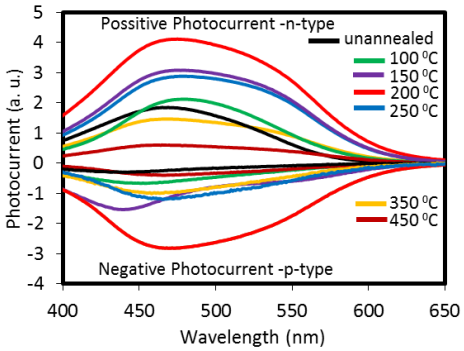

Figure 1: Spectral response of sulfur treated n-type Cu_2O and p-type Cu_2O films in a PEC as a function of annealing temperature.

performance compared to that of unannealed samples by about a two fold and eight fold for sulfur treated n-type Cu_2O and p-type Cu_2O films respectively.

The influence of sulfur and the annealing on the Cu_2O structure was examined using High energy X-ray diffraction measurement at SPring-8. The analysis revealed that the procedure of sulfur treatment itself creates Cu_xS in crystalline form on the Cu_2O film reducing surface defects and shows a significant thermal stability against formation of CuO.

References

[1]. K.M.D.C. Jayathilaka et al., Physica Status Solidi RRL **8,** (6) (2014) 592.

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