Observation of interface modification of electrodeposited p-Cu_2O thin films in an aqueous electrolyte

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Interface engineering via modification of semiconductor surfaces of junction devices is a powerful technique to improve the performance of devices. In addition, semiconductor material Cu_2O has recently gained a considerable attention as a low cost semiconductor material suitable for developing thin film solar cells, water splitting in photoelectrochemical cells and gas sensors. Indeed, the possibility of relative band edge shifts of Cu_2O with suitable interfacing materials will pave the way for interface engineering to improve the efficiency of those devices. In this study we have investigated this possibility of using electrodeposited p-type cuprous oxide thin films deposited using a lactate bath containing 3 M sodium lactate and 0.4 M $CuSO_4$ at various pH values. These Cu_2O films were used in a photolectrochemical cell to form semiconductor/electrolyte junctions in a 0.1 M sodium acetate aqueous solution and then to measure the flat band potential variations with the pH of the Cu_2O film deposition baths. It was observed that pH value of the Cu_2O film deposition bath is very sensitive to the flat band potential. This result gives a direct evidence that the surface of Cu_2O film is modified at the Cu_2O/electrolyte interface producing a relative band edge shift yielding the observed flat band shifts. We observed a general trend of flat band potential shift of about 350 mV in the positive direction, as the pH of the deposition bath was changed from 7 to 12.5. The observed shift in the flat band potential in the positive direction is very useful for the water splitting reaction because the valence band edge of Cu_2O is shifted positively relative to the oxygen redox potential. Our observation of highest photoresponse for Cu2O thin films prepared at pH 13.5 is a direct evidence for the positive shift of the band edges. The observation of the interface modification of Cu_2O in aqueous electrolyte may be further extended to other suitable interfaces for developing Cu_2O based junction devices.

Key words: Cuprous oxide, Electrodeposition, Interface engineering, flat band potential

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