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Improvement of p-Cu_2O/Au interface by controlling the pH of the electrodeposition bath of Cu_2O

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Metal-Semiconductor junction studies play a very important role in discovering new junction properties leading to improved electronic devices. Indeed, Schottky junction is among the fundamental structures used in modern optoelectronics and microwave devices. In this regard, low cost and eco-friendly metal-semiconductor devices with inexpensive materials and fabrication techniques are extremely important. Among other materials, p-Cu_2O thin films grown by electrodeposition method have attracted as potential candidates for developing Cu_2O based low cost Schottky junction devices. In this study, dependence of the p-Cu_2O/Au junction properties on the pH of the Cu_2O film deposition bath has been investigated for the development of low cost devices. p-Cu_2O thin films were potentiostatically electrodeposited in a three electrode electrochemical cell containing 3M lactic acid, 0.4M $CuSO_4$ and NaOH at different pH values. p-Cu_2O/Au Schottky junctions were fabricated by sputtering Au on masked Cu_2O samples. Dark Capacitance – Voltage measurements (Mott-Schottky plots) of the fabricated devices revealed that a positive shift of 620 mV of the flat band potential against Au for the change in pH of the film deposition bath from 7.0 to 13.0. This positive shift is significant when compared to the positive shift of 350 mV at the p-Cu_2O/electrolyte interface observed earlier. The interaction of surface atoms with the electrolyte species at the Cu_2O/electrolyte interface and the presence of bare surface atoms at the Cu_2O/Au interface might have led to this improvement. The positive shift of the flat band potential manifests that the positive shift in the valence band edge of p-Cu_2O relative to the Fermi level of Au increases the barrier height at the p-Cu_2O/Au interface. Thus, the study reveals that the barrier height at the p-Cu_2O/Au interface can be controlled with the pH of the film deposition both. As observed, dark Current-Voltage measurements on p-Cu_2O/Au devices resulted nearly ohmic behavior for low pH values and non ohmic diode behavior for high pH values. This suggests that for high pH values of the film deposition bath of p-Cu_2O improved Schottky junctions can be in fabricated with Au, suitable for various device applications such as rectifying circuits, photovoltaics, etc.

Keywords*:* p-Cu_2O, Electrodeposition, Schottky junction, Capacitance – Voltage measurements

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