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Enhancement of photovoltaic performance of Cu_2O homojunction by introducing a ZnO buffer layer

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Cuprous oxide (Cu_2O) is a semiconductor material having the capability of producing a theoretical conversion efficiency of 20% which is acceptable for solar energy applications. In this investigation, we have explored the possibility of improving open circuit voltage (V_{oc}) of Cu_2O homojunctions by introducing a ZnO buffer layer in between n- and p-Cu_2O layers. The thin buffer layer may be able to develop an additional potential drop across the interface improving V_{oc} without hindering short-circuit current density (J_{sc}). In this investigation, n-Cu_2O thin films were electrodeposited on Ti substrates at -200 mV vs Ag/AgCl for 30 minutes in an acetate bath. Samples were then annealed at 175 ^oC for 30 min in air. ZnO thin film was deposited on Ti/n-Cu_2O film by employing Successive Ionic Layer Adsorption Reaction (SILAR) technique using 0.1 M $Zn(NH_3)_4^{2+}$ aqueous solution. Resulted samples were annealed at 175 ^oC for 10 minutes. p-Cu_2O thin film was electrodeposited on Ti/n-Cu_2O/ZnO electrode at -450 mV vs. Ag/AgCl for 45 minutes in a lactate bath. Surface of p-Cu_2O was exposed to ammonium sulphide vapor in order to prepare an ultra-thin Cu_2S layer. Finally, 2x2 mm^2 Au spots were sputtered on the coper sulphide layer. A set of Ti/n-Cu_2O/ZnO/p-Cu_2O/Au devices having different thicknesses of ZnO layers was prepared by changing the number of successive adsorption cycles and characterized them by using dark and light current voltage measurements. Dark and light current voltage characteristics revealed that the device fabricated using 3 cycled ZnO layer produces the best photoactive performance. Without the buffer layer, the device produced V_{oc} of 384 mV and J_{sc} of 8.1 $mAcm^{-2}$, under AM 1.5 illumination. With the ZnO buffer layer the device V_{oc} improved up to 416 mV and J_{sc} up to 9.1 $mAcm^{-2}$. Our results revealed the possibility of improving both V_{oc} and J_{sc} of the Cu_2O homojunction by introducing a ZnO buffer layer.

Keywords: Buffer Layer, Cu_2O, Electrodeposition**,** Homojunction, ZnO

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