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Photoelectrolysis of water using electrodeposited Cu_2O electrodes

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At present, fossil fuels are the main energy contributor of the world's energy needs but gradually depletion of fossil fuels is heading towards an energy crisis. Therefore it is very important for us to find out a renewable clean energy source to minimize the use of fossil fuels and environmental problems created by the burning fossil fuels. Among the suggested alternative fuels, hydrogen is one of the best and it can be produced by photoelectrolysis of water. Finding correct semiconducting materials and techniques are the key areas of research in the development of an efficient photoelectrolysis device. Ultra low cost electrodeposited cuprous oxide (Cu_2O) is a good candidate material because it has required semiconductor properties for the process. p-Cu_2O electrode electrolyte system requires external bias to produce photocurrent and this can be overcome by using n-Cu_2O. However, in our previous studies, we have observed the possibility of enhancement of photocurrent at zero bias using double electrode system (electrodeposted n-Cu_2O, thermally grown p-Cu_2O, electrolyte system). In this investigation it was studied the possibility of photoelectrolysis of water using electrodeposited n- and p-Cu_2O thin film electrodes as a double photoelectrode system in a 0.1 M sodium acetate photoelectrochemcal cell. n-Cu_2O thin films on Ti substrates were potentiostatically electrodeposited at −200 mV Vs Ag/AgCl for 60 minutes in an aqueous solution containing 0.1 M sodium acetate and 0.01 M cupric acetate. The initial pH of the deposition bath was adjusted to 6.1. The temperature of the electrolyte was maintained at 55 °C and counter and reference electrodes were a platinum plate and a Ag/AgCl electrode, respectively. p-Cu_2O thin films were electrodeposited on Ti substrate at -400 mV Vs Ag/AgCl for 40 min in a three-electrode electrochemical cell containing a 3 M sodium lactate and 0.4 M $CuSO_4$ solution at pH 11. During the electrodeposition, the baths were continuously stirred using a magnetic stirrer. Prior to the film deposition, substrates were cleaned with detergent, dilute HCl, distilled water, and finally ultrasonicated in distilled water. Electrolytic solutions were prepared with distilled water and reagent-grade chemicals. n-Cu_2O thin films are annealed at 150 ^oC for 10 min in air. Possibility of photoelectolysis using electrodeposited Cu_2O has been investigated using dark and light current–voltage measurements in a three-electrode electrochemical cell containing 0.1 M aqueous sodium acetate solution. Results reveal that photoelectrolysis process is enhanced by 380% when n- and p-Cu_2O double electrode system was operated compared to the n-Cu_2O single electrode system.

Keywords: Cu_2O, I-V characteristics, Photoelectrolysis