4.3 FABRICATION AND CHARACTERIZATION OF ELECTRODEPOSITED NANOCRYSTALLINE / MICROCRYSTALLINE CUPROUS OXIDE THIN FILM SOLAR CELLS

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ABSTRACT

The quest and need for clean and economical energy sources have increased interest in the development of solar energy application. In particular, direct conversion of solar energy to electrical energy and chemical energy using semiconductor photoelectrodes has attracted attention for many decades. Among the various metal oxide materials for solar energy application, a promising material is cuprous oxide (Cu_2O) and is one of the oldest known semiconductors. It is low cost and non toxic and its component elements are readily available. It has a direct band gap of about 2 eV and a high optical absorption coefficient. Nanocrystalline thin films increase the effective surface area of the films as compared with the microcrystalline thin films. Therefore preparation of nanoparticles of Cu_2O is of special importance to improve the solar energy conversion efficiency. In this study, Cu_2O films were deposited electrochemically on Ti substrates. In our investigation, we have developed a simple electrochemical technique to fabricate the Cu_2O/Cu_xS heterojunction and used it to prepare a thin film photovoltaic solar cell. Electrodeposited Cu_2O thin films on Ti substrates were sulphided by directly applying an aqueous solution of Na_2S on to Cu_2O films and annealed at 200 ^{0}C for a few minutes. Then the samples were exposed to NH_4S gas for a few seconds. It was observed that the photovoltaic properties and the diode characteristics of nano/micro/Cu_2O/Cu_xS structures were better than that of micro/Cu_2O/Cu_xS structures. The maximum conversion efficiency of the micro/Cu_2O/Cu_xS cell was 0.12% (V_{oc}= 240 mV, and I_{sc}= 0.86 mA/cm^2) and that of the nano/micro/Cu_2O/Cu_xS cell was 0.28% (V_{oc}= 420 mV, and I_{sc}= 2.1 mA/cm^2) under AM1.5 illumination.