ABSTRACT

Investigations of the development of environmentally friendly low cost solar cells with very cheap semiconductor materials are extremely important for development of solar energy technology. Cuprous Oxide is non toxic, inexpensive and its component elements are readily available. This semiconducting material is attractive because 2eV band gap energy is suitable for solar cell and sensor applications. Cu_2O thin films are prepared by several deposition methods and among them electrodeposition is attractive because of its simplicity, low cost and low temperature process.

Cuprous oxide thin films were electrodeposited in a cupric acetate bath and resulting films were investigated in a photoelectrochemical cell for determining the intrinsic defect density variations. Depth profiles of the current carrier generation in the thin films were studied using the variation in the absorption depths of incident photons. Magnitudes and sign reversal of the photocurrents generated by the incident monochromatic light were used for this purpose. It was observed that by controlling the pH value of the deposition bath density of both Cu and O vacancies, which are responsible for acceptor and donor levels respectively, can be controlled and thereby it is possible to electrodeposit either n-type or p-type cuprous oxide thin films. Films were characterized using photocurrent spectral response, capacitance-voltage (CV), scanning electron microscopy (SEM), Energy Dispersive X-Ray (EDX), Atomic Force Microscope (AFM) and X-ray diffraction (XRD) measurements. Direction and wavelength dependence of photocurrent of the thin film electrodes in a photoelectrochemical cell demonstrated the n- and the p-type behavior of the films and the existence of the p-n homojunction. It was observed that both pH value and cupric ion concentration of the depositing acetate bath determine the conduction type of the films. Cu_2O films with p-n homojunction were obtained by single step and two step electrodeposition.

Grain size of polycrystalline semiconductor thin films in solar cells may be optimized to enhance the efficiency of solar cells. In this thesis we report results on an investigation carried out on electrodeposition of cuprous oxide (Cu_2O) thin films on Ti substrates to obtain n-type thin films of small crystallites and sulphidation of them to produce a thin film solar cell. For the electrodeposition of Cu_2O films, pH of an aqueous acetate bath was optimized to obtain Cu_2O films of grain size about 100 nm, that were then used as templates to grow thicker n-type nanocrystalline Cu_2O films. XRD and SEM analysis revealed that the films were of single phase and the substrates were well covered by the films. A heterojunction of Cu_2O/Cu_xS was formed by partially sulphiding the Cu_2O films using an aqueous sodium sulphide solution. Resulting $Ti/Cu_2O/Cu_xS/Au$ solar cell structure produced an energy conversion efficiency of 0.54 % , V_{oc} = 610 mV and I_{sc}= 3.4 $mAcm^{-2}$, under AM 1.5 illumination. This is a significant improvement compared to the use of microcrystalline thin film Cu_2O in the solar cell structure where the efficiency of the cell was limited to 0.11%.