**Fabrication of CuO/Cu2O Heterojunction and Its Local Structural Characterization**

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**Abstract**

Cuprous oxide (Cu2O) thin films on Ti substrate were potentiostatically electrodeposited at -200 mV in an acetate bath. For the growth of p-type cupric oxide (CuO) thin films, Cu2O thin films were annealed at 500 oC for 30 min in air. In order to fabricate CuO/Cu2O hetorojunction, thin film of Cu2O was potentiostatically electrodeposited on Ti*/*CuO electrode. Deposits were characterized by using X-ray diffraction (XRD) and scanning electron micrographs (SEM). Results revealed that well covered n-type polycrystalline Cu2O thin film can be electrodeposied on Ti/CuO electrode at -550 mV Vs the SCE in an acetate bath. The CuO*/*Cu2O heterojunction gave the open circuit voltage (Voc) of 210 mV and short circuit current (Jsc) of 310 *μ*A/cm2. Layer by layer structural properties of the electrodeposited Ti/CuO/Cu2O thin film heterojunction have been studied by means of the XRD and the X-ray absorption spectra (XAS) with different grazing angles of the incident X-ray beam. Results reveal that Cu2O and CuO are high quality semiconducting thin films but amorphous structure is formed between CuO and Cu2O while Cu2O deposition on CuO. It can be expected that amorphous structure formed in the middle of the CuO/Cu2O heterojunction attributes better lattice matching between CuO and Cu2O interface.

**1. Introduction**

Solar energy is considered as the most promising alternative energy source to replace environmentally distractive fossil fuel. However, it is a challenging task to develop solar energy converting devices using low cost techniques and environmentally friendly materials. Cuprous oxide (Cu2O) and cupric oxide (CuO) are possible candidates for photovoltaic applications because of their reasonable electrical and optical properties [1, 2]. Among the various Cu2O deposition techniques [3–7], electrodeposition [8–11] is an attractive one because of its simplicity, low cost, low-temperature process and possibility of making large area thin films. Although fabrication of Cu2O and CuO based heterojunctions with other materials have been reported [11-16], investigations of CuO/Cu2O heterojuction are very limited in the literature because of inability to grow n-type Cu2O (or CuO). Both Cu2O and CuO have been considered as nonstoichiometric p-type semiconductors till Siripala *et al* introduced n-type Cu2O in 1986. They have reported that electrodeposited Cu2O films in slightly acidic aqueous baths behave as n-type conductivity [17], whereas all the other methods yield p-type material. In the present investigation, the photoactive p-CuO*/*n-Cu2O heterojunction has been fabricated using the potentiostatical electrodepostion technique, and layer by layer structural information of the electrodeposited CuO/Cu2O heterojunction have been studied by means of the X-ray diffraction (XRD) and the X-ray absorption spectra (XAS) with different grazing angles of the incident X-ray beam using the synchrotron radiation.

**2. Experimental**

Cu2O thin films on Ti substrate were potentiostatically electrodeposited at -200 mV Vs saturated calomel electrode (SCE) in a three electrode electrochemical cell containing 0.1 M sodium acetate and 0.01 M cupric acetate aqueous bath. Cupric acetate are used as Cu2+ source while sodium acetate are added to the solution making complexes releasing copper ions slowly into the medium allowing a uniform growth of Cu2O thin films. The counter electrode was a platinum plate and reference electrode was SCE. Temperature, pH and stirring speed of the baths were maintained at values of 55 oC, 6.6 (normal pH of the bath) and 300 rev./min respectively. Ti/Cu2O thin films were annealed at 500 oC for 30 min in air for the growth of p-type CuO thin films. In order to fabricate CuO/Cu2O heterojunction, thin films of Cu2O were potentiostatically electrodeposited on Ti*/*CuO electrodes at different deposition potentials Vs SCE while maintaining the same electrolytic conditions, which used to deposit Cu2O on the Ti substrate. Deposition period was varied form 240 min to 120 min in order to obtain sufficient thickness of the films. For the completion of the device, very thin gold (Au) grid (1×8 mm2) was deposited on the Cu2O thin film in order to complete front contact to the CuO*/*Cu2O heterojunction. The bulk structure, the surface morphology and the optoelectronic properties of the Cu2O*/*CuO heterojunction were determined by the XRD measurements using a Rigaku (Model RADA, CN2155D5) X-ray diffractometer, the SEMs using a JEOL (Model JSM-6060) scanning electron microscope and dark and light current–voltage characteristics, respectively. In order to study the layer by layer structural deformation localized around