Cathodic Electrodeposition of Chalcogenide Thin Films Cu_4SnS_4 for Solar Cells

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ABSTRACT

Copper tin sulfide thin films were electrodeposited on the indium tin oxide glass substrate in a bath containing $CuSO_4$, $SnCl_2.2H_2O$ and $Na_2S_2O_3.5H_2O$ at pH 1 and temperature 25°C. The cyclic voltammetry of the film formation was studied in a potential range of 1000 mV to –1000 mV versus Ag/AgCl. Influence of different deposition potentials on the surface morphology and films structure of Cu_4SnS_4 films was investigated by atomic force microscopy and X-ray diffraction, respectively. The X-ray diffraction data showed the intensity of major peaks at $2\theta = 30.2°$ which belonged to (221) plane of Cu_4SnS_4. The atomic force microscopy images indicated that the electrodeposited films were smooth, compact and uniform at deposition potentials of -600 mV versus Ag/AgCl. The bandgap energy and type of optical transition were determined from optical absorbance data. The film was found to exhibit direct transition in the visible spectrum with a bandgap value of about 1.58 eV.

Key words: Electrodeposition, Cyclic voltammetry, Thin films, Semiconducting material

INTRODUCTION

In search of new semiconducting materials for efficient solar energy conversion through photoelectrochemical solar cells, metal chalcogenides are increasingly studied. The vast preparation and studies of metal chalcogenides thin films can be classified into two categories: binary compounds and ternary compounds. Examples of binary compounds are MnS (Gumus et al., 2005), ZnSe (Riveros et al., 2001), Cu_2S (Anuar et al., 2002), SnSe (Zainal et al., 2003) and SnS (Subramanian et al., 2001) while $CuInSe_2$ (Pathan and Lokhande, 2005), CdSSe (Mane and Lokhande, 1997) and $CuInS_2$ (Berenguier and Lewerenz, 2005) are examples of ternary metal chalcogenides. For photovoltaic cells, ternary systems of the compound semiconductors are particularly interesting. Among the ternary semiconducting materi-