Study of Sulphidation of Electrodeposited Cu_2O Thin Films for Solar Cell Applications

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ABSTRACT

Cuprous oxide (Cu_2O) layers were potentiostatically electrodeposited on glass/ITO substrates and then they were partially sulphided using Na_2S and H_2S. Resulting layers were used to fabricate ITO/n-Cu_2O/p-Cu_xS thin film solar cells. Spectral response measurements showed that the cell structure exhibits both n- and p-type behavior. Sulphidation of Cu_2O does not produce Cu_xS thick layers adequate for efficient heterojunction solar cell, but improved the photovoltaic activity. The best device fabricated shows V_{oc} = 240 mV and I_{sc} = 1.6 mA/cm^2 under AM 1 artificial illumination.

1. INTRODUCTION

Cuprous oxide is a low-cost and non-toxic semiconducting material with potential applications in solar energy converting devices [1-3]. The band gap of cuprous oxide is 2.0 eV, which is in the acceptable range of window materials for photovoltaic applications. The method of electrodeposition is an attractive technique because of its simplicity and the possibility for use in large area thin film solar cells for terrestrial application. Electrodeposited cuprous oxide films behave as an n-type semiconductor material [5] irrespective of the well established p-type conductivity of this material prepared by other methods [1], and type conversion occurs after annealing in air at temperatures over 300° C [2]. Annealing in air at temperatures below 300° C improves the bulk crystalline properties and photoelectrochemical cell response indicating the improvement of electrical properties [2]. Electrodeposited Cu_2O thin films for application as a window material in photovoltaic devices, combined with suitable low band gap p-type semiconductor such as copper sulphide ($E_g \approx 1.2$ eV) or copper indium diselenide ($E_g \approx 1.1$ eV), is an important subject for investigation.

This paper reports the photovoltaic properties of ITO/n-Cu_2O/p-Cu_xS thin film structures prepared by sulphidation of the electrodeposited cuprous oxide thin films.