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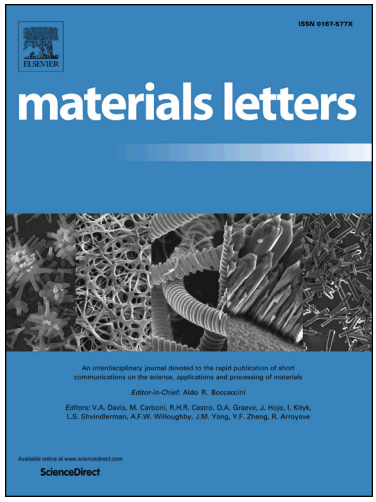

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Characterization of $CuGa_{1-x}Ti_xS_2$ thin films synthesized by a facile non vacuum method

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Abstract

In present paper, a promising intermediate band (IB) material of $CuGaS_2$ thin films incorporating with titanium (Ti) have been successfully fabricated by a facile non-vacuum method. Binary sulfides used as raw material are firstly tried to fabricate Ti-substituted $CuGaS_2$ thin films via ball milling and spin-coating technique. The experimental measurements showed that the obtained $Cu_2Ga_{1-x}Ti_xS_2$ thin films are composed of chalcopyrite structure with well crystallinity. A slightly left shift of (112) diffraction peaks indicated the successful doping of Ti element. The Hall Effect measurement exhibited the carrier concentration raised obviously from 1.538×10^{12} (x = 0) to 1.134×10^{13} cm^{-3} (x = 0.06) with increasing of Ti doping concentration. More important, the UV–vis–NIR spectra exhibited a strong optical absorption in Ti-substituted $CuGaS_2$ films, which indicated the IBs were roughly formed in the films.

***Keywords*:** Solar energy materials; Intermediate band; photovoltaic; Ti-substituted $CuGaS_2$;

Introduction

In recent years, intermediate band solar cells (IBSC) have been drawing considerable attention due to the higher photocurrent without sacrificing the open circuit voltage for the high conversion efficiency of solar cells [1]. The estimated theoretical limit efficiency of IBSC is about 63.2%, much greater than 40.7% of the single-junction solar cell [2]. The methods of fabricating intermediate band (IB) material are generally classified into three categories i.e., quantum dots [3], highly mismatched alloys [4], and impurity doping in semiconductors [5]. Among them, impurity doping is a relatively easy method to fabricate IB, and the intermediate states obtained have higher electron density, which leads to a stronger optical absorption. The first principle calculations indicate certain transition metals are suggested as promising candidate materials to form IB in chalcogenides [6], such as

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