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# Synthesis of quaternary $\text{Cu}_2\text{NiSnS}_4$ thin films as a solar energy material prepared through « Spray » technique

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## Abstract

$\text{Cu}_2\text{NiSnS}_4$  (CNTS) is considered as a promising quaternary semiconductor, suitable for absorber layer in thin film solar cells because of their non toxic and earth-abundant elements. Here, we have successfully deposited CNTS thin films onto glass substrates by the Spray Sandwich method. These thin films were only obtained at substrate temperature 300 °C with 60 min spray duration. The prepared CNTS thin films exhibited high absorption coefficient ( $\sim 10^4 \text{ cm}^{-1}$ ) in the visible region with direct band gap energy of 1.23 eV, suggesting its potential use in thin film solar cells.

**Keywords:** Thin films,  $\text{Cu}_2\text{NiSnS}_4$ , Solar energy material, Spray Sandwich.

## 1. Introduction

Recently, quaternary chalcogenide semiconductors  $\text{Cu}_2\text{XSnS}_4$  (X= Ni, Zn, Co, Mn, Fe) have drawn a lot of attention as an absorber for applications in thin-film solar cell devices because of excellent optical, electrical and chemical properties. Among them,  $\text{Cu}_2\text{NiSnS}_4$  (CNTS) thin film is considered as one of the promising candidates for low-cost thin films solar cells. Indeed, this semiconductor exhibits suitable band gap energy of 1.1-1.5 eV and high absorption coefficient about ( $\sim 10^4 \text{ cm}^{-1}$ ) [1]. There are few reports concerning the preparation of CNTS based thin films. Yang et al. synthesized CNTS thin films with a stannite structure by a facile one-step electro-deposition method followed by the annealing treatment which realized in  $\text{H}_2\text{S}/\text{N}_2$  mixed at atmosphere [2]. Chen et al. fabricated CNTS thin films with a cubic structure using an electro-deposition method followed by sulfurization at high temperature [3]. Based on CNTS thin films, only electro-deposition method has been used.

We report, for the first time, the fabrication of cubic CNTS thin films using a Spray Sandwich method without any annealing treatment. In fact, the Spray Sandwich method is an advanced chemical

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