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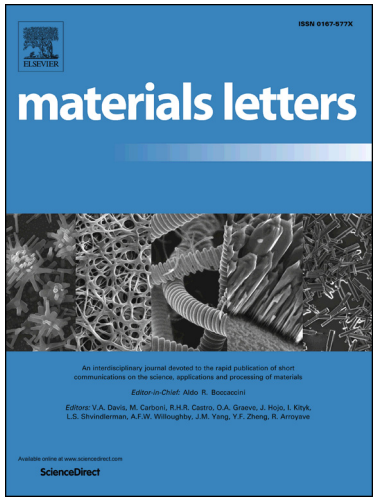


# Studies on the electrical properties of $Cu_2NiSnS_4$ thin films prepared by a simple chemical method

N. Bitri, S. Dridi, F. Chaabouni, M. Abaab

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# Studies on the electrical properties of $Cu_2NiSnS_4$ thin films prepared by a simple chemical method

N. Bitri*, S. Dridi, F. Chaabouni and M. Abaab.

University Tunis El Manar, National School of Engineering of Tunis, Photovoltaic Laboratory and Semi-conductor Materials, 1002, Tunis, Tunisia.

* E-mail: nabila.bitri@gmail.com

**Abstract**

In this paper, the $Cu_2NiSnS_4$ (CNTS) thin films were synthesized by a simple chemical method using Spray Sandwich technique without any annealing treatment. The prepared CNTS thin films were studied by X-ray diffraction (XRD) and impedance spectroscopy. The result obtained from the XRD measurements showed that CNTS thin films are polycrystalline in nature with cubic structure and preferred orientation along (111) plane. Electrical study of CNTS thin films is investigated by impedance spectroscopy for the first time. The activation energies $E_a$ obtained from both angular frequency and DC conductivity are found to be 1.18 and 1.1 eV, respectively.

**Keywords:** Thin films, $Cu_2NiSnS_4$, Electrical properties, Solar energy materials, Spray Sandwich.

## 1. Introduction

Much interest has been focused on the quaternary chalcogenide compound of the type $A^{II}B^{I}C^{I}D^{IV}$, which has emerged in recent years as a useful material in the application as absorber in thin film solar cell. The CNTS material belongs to the group of chalcogenide compounds and exhibits a p-type conductivity [1], a direct band gap energy of 1.1-1.5 eV and high absorption coefficient about (~$10^4$ $cm^{-1}$) [2]. Comparing with $CuInSe_2$ (CIS), $CuInGa(S,Se)_2$ (CIGS) and CdTe materials [3], the CNTS compound contains earth-abundant constituents without toxicity. Recently, several methods have been used for the fabrication of CNTS, including hydrothermal [1], electrodeposition [4,5], hot injection [2], solvothermal [6-8], electrospinning [9] and spin coating [10]. In this work, the method employed for preparing CNTS thin films is the Spray Sandwich. To the best of our knowledge, there has been no reports on the studies of electrical properties of CNTS thin films were investigated by impedance spectroscopy. The electrical properties of $Cu_2FeSnS_4$ (CFTS) and $Cu_2CoSnS_4$ (CCTS) thin films also belong to the family of