A.V.V.M. Sri Pushpam College (Autonomous)

Poondi– 613 503, Thanjavur-Dt, Tamilnadu

(Affiliated to Bharathidasan University, Tiruchirappalli – 620 024)

3.7.1 Number of Collaborative activities per year for research/ faculty exchange/ student exchange/ internship/ on –the-job training/ project work

Collaborating Agency:

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Bishop Heber College (Autonomous), Tiruchirapalli

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Date:07.07.2016

LINKAGE
For the year 2016-2017

Between

1. Dr. K. Ravichandran
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PG & Research Department of Physics
A.V.V.M Sri Pushpam College
(Autonomous), Poondi – 613 503.

&

2. Dr. C. Ravi Dhas
Head, PG & Research Department of Physics
Bishop Heber College (Autonomous)
Tiruchirapalli – 620 017.

Considering the significance of the noble cause for the student community, we have come forward to collaborate with each other to exchange research knowledge, expertise, laboratory and library facilities to the process of scientific research and education in the field of materials science. The parties (mentioned above as 1. & 2.) have had preliminary discussion in this matter and have ascertained areas of broad consensus. The parties now therefore agreed to enter in writing these avenues of consensus, under a flexible linkage, and this project aims to fill the gap between knowledge demand and subject expertise related to the mentioned field.

Joint Responsibilities

- Sharing of laboratory facilities, library resources, database etc.,
- Joint Publication of research articles, books, magazines, bulletins etc.,
- Jointly organizing conferences, seminars, symposia and workshops.
- Submitting joint proposals for research funding from agencies like UGC, CSIR, DST and TNSCST.

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Dr. K. Ravichandran

Dr. C. Ravi Dhas

Effect of sputtering power on properties and photovoltaic performance of CIGS thin film solar cells

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$CuInGaS_2$ (CIGS) thin films were fabricated by DC magnetron sputtering by varying the sputtering power (70, 90, 110 and 130 W). The X-ray diffraction revealed the formation of tetragonal structure with (1 1 2) preferential orientation. The film prepared at 90 W has better crystallinity with minimum dislocation density and strain. From the scanning electron microscopy analysis, it was found to be a denser and larger in grain formation. The elemental quantification and stoichiometric ratio of the CIGS films were confirmed by energy-dispersive spectra. The optical band gap was found using Tauc plot, and it varied from 1.20 to 1.52 eV. The transport conduction mechanism involved in CIGS films was identified from DC four-probe method. Raman studies reveal that all the films composed of CH and CA ordering. The solar cell measurements indicate that high power conversion efficiency (η) of 0.29% and short-circuit current density of (J_{sc}) of 4.51 mA/cm² obtained for the film deposited at 90 W.

Keywords: DC magnetron sputtering, CIGS thin film, Raman spectroscopy, *J–V* characteristics

Introduction

$CuInGaS_2$ (CIGS)-based chalcopyrite thin films having band gap around ~1.4 eV has attracted the field of energy conversion due to its near optimum band gap and desirable absorption coefficient. The well-known chalcopyrite semiconductor thin films such as Cu (In, Ga) Se_2 (CIGS), Cu In Se_2 (CIS) and Cu In S_2 (CIS) are gaining more importance due to their high absorption coefficient, high stability offering in electronic devices and their anti-irradiation performance.[1,2] Approaching optimum band gap of 1.5 eV for solar cell applications would be the key factor to achieve higher conversion efficiency-based CIGS thin film.[3] The classical $Cu(In,Ga)Se_2$ absorber materials-based solar cells have reached the maximum conversion efficiency greater than 20%.[4] Sulfurized and selenized absorber layers which contains the combination of $Cu(In,Ga)SSe_2$ materials are getting importance in solar cell application due to its band gap nature as well as superior absorption coefficient.[5,6] CIGS absorber layer have been fabricated by various deposition methods such as sputtering, evaporation, spray pyrolysis and electrodeposition.[7,8] The $Cu(In,Ga)S_2$ (CIGS) absorbers prepared by magnetron sputtering or other deposition techniques has an efficiency of 12.9%.[9,10] Though, low-cost chemical techniques were adopted to prepare CIGS thin films, sputtering techniques have shown superior quality CIGS thin film preparation. Also, sputtering techniques can offer a good control over composition and crystallinity of the device. Moreover, the scalable devices can be made through sputtering techniques with desired composition and crystallinity control. The preparation of one-step chalcopyrite thin films through sputtering process is having advantages of low-cost large-scale production compared to the conventional three-stage process. Most of the reports were based on sputter deposition by co-sputtering of (CuGa) binary target and (In) target[11] or ternary target[12] assisted with the rapid thermal annealing in the H_2Se/H_2S ambient. The major drawback in the above-mentioned methods is that the stoichiometric incompetency of CIGS films.[11] In this context, reactive sulfurization technique is found to be more promising alternative strategy in the fabrication of better stoichiometric CIGS films.[13] The variation in sputtering power as a deposition parameter in the preparation of CIGS films was less studied.

In this present work, we have made an attempt to deposit CIGS thin films by one-step DC reactive magnetron sputtering using a single ternary target (Cu, In and Ga) with H_2S as a reactive gas under different sputtering power. The obtained films were investigated by X-ray diffraction (XRD), scanning electron microscopy (SEM), energy-dispersive spectra (EDS), electrical properties, optical properties and Raman spectra. The prepared CIGS thin films were then used as an absorber layer to study the performance in hetero-junction solar cell devices.

Materials and methods

Preparation of CIGS thin film

CIGS thin films were deposited by DC reactive magnetron sputtering using CuInGa ternary alloy target (purchased from

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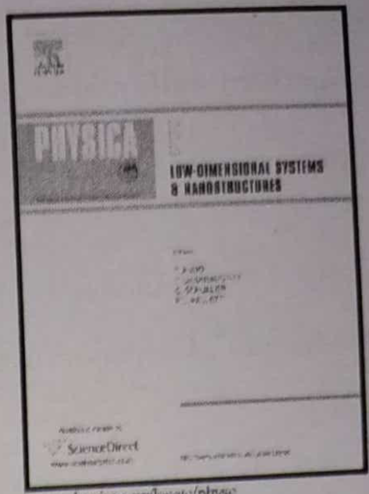
Received 19 May 2016; accepted 13 July 2016
DOI 10.1080/14328917.2016.1214226



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Self assembled sulfur induced interconnected nanostructure TiO_2 electrode for visible light photoresponse and photocatalytic application

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PII: S1386-9477(17)30201-1
DOI: http://dx.doi.org/10.1016/j.physe.2017.04.017
Reference: PHYSE12790

To appear in: *Physica E: Low-dimensional Systems and Nanostructures*

Received date: 8 February 2017
Accepted date: 20 April 2017

Cite this article as: B. Anitha, C. Ravidhas, R. Venkatesh, A. Moses Ezhil Raj. K. Ravichandran, B. Subramanian and C. Sanjeeviraja, Self assembled sulfu induced interconnected nanostructure TiO_2 electrode for visible ligh photoresponse and photocatalytic application, *Physica E: Low-dimensiona Systems and Nanostructures,* http://dx.doi.org/10.1016/j.physe.2017.04.017