INTERNATIONAL JOURNAL OF RESEARCHES IN BIOSCIENCES, AGRICULTURE & TECHNOLOGY
© VISHWASHANTI MULTIPURPOSE SOCIETY (Global Peace Multipurpose Society) R. No. MH-659/13(N)
www.vmsindia.org

Synthesis Of Cds Incorporated Sio_2 Nanocomposite For Photovoltaic Application

A. M. Kute and S. A. Waghuley*
Department of Engineering Physics, Shri Sant Gadge Baba College of Engineering and Technology, Bhusawal 425203, India.
*Department of Physics, Sant Gadge Baba Amravati University, Amravati 444 602, India.
* Corresponding author: E-mail: sandeepwaghuley@sgbau.ac.in

Abstract
In present study, the photovoltaic properties of copper sulfide (CdS) incorporated silicon oxide (SiO_2) nanocomposite was investigated. The nanocomposite between CdS and SiO_2 was prepared by solid state diffusion method. During the process of solid state diffusion, silicic acid was used as source of silicon. The prepared composite characterized by X-ray diffractions, scanning electron microscopy, and photovoltaic measurements. The film deposited on ITO glass plate shows uniform morphology. IV characteristics of PV cell studied and found that power conversion efficiency was 1.26 % calculated for 15 wt.% CdS loaded SiO_2 nanocomposite having fill factor 0.354.
Key words: cadmium sulfide; photovoltaic; silicon rich

Introduction

In recent years, Quantum dot sensitized solar cells (QDSSCs) have attracted great attention in the past decade because of the recent popularity of the synthesis of well-defined QDs to construct cost-effective photovoltaic solar cell [1, 2]. Of particular interest are CdX (X = S, Se, and Te) QDs, which have small and size-dependent band gaps and thus provide new opportunities for harvesting light energy in the visible and infrared regions of solar light [3,4].

CdS has gained much attention as promising solar cell absorber. Chuan He [5] prepared a CdS/Si nano hetero junction array for harvesting the energy of sunlight. In this study he reported that CdS/Si NPA has average reflection less than 7 % in the wavelength 200-1000 nm. Yong Li et al [6] fabricated CdS/Si nanostructure array through growing CdS nanocrystals on the silicon nano porous pillar array using a CBD method. In this study Yong Li et al reported that electronic properties of CdS/Si can be tuned through the annealing treatment. A.S.Obaid et al [7] used ITO substrate to construct solar cell using CdS. Cadmium sulfide QDS are easy to synthesize having direct band gap of 2.4 ev at room temperature making it efficient in the visible region[8,9]

In the present study, we have synthesized SiO_2 rich CdS composites for photovoltaic application. The composites were prepared by altering the incorporation concentration of CdS in composites. In this work, CdS nanoparticles were synthesized by chemical route. For incorporation of CdS in SiO_2, solid state diffusion route was adopted. The as-obtained composites further investigated for photovoltaic application. The significant power conversion efficiency was extracted from the prepared materials systems.

As-prepared sample was characterized using X-ray diffractions (XRD), FTIR and scanning electron microscopy (SEM) measurements.

Material and Methods

The conducting ITO glass commercial substrates were washed in acetone. For the synthesis of CdS/Si composites, AR grade (SD fine, India) chemicals were used without any further purification. In the present work, chemical route approach was used for the synthesis of CdS nanoparticles. The cadmium chloride ($CdCl_2$) and sodium sulfide (Na_2S) were used as starting chemicals for the synthesis of CdS nanoparticles. Both chemicals $CdCl_2$ and Na_2S were mixed in distilled water. As-obtained CdS nanoparticles were used to prepare composite with SiO_2 using solid state diffusion method. For this, silicic acid was utilized as source of SiO_2. The heating of silicic acid above 800 °C, results in oxidation of silicic acid. By considering this principle, for fixed value of silicic acid, prepared CdS added in silicic acid in wt.% manner (5-25 wt.%) with an interval of 5 wt.%. The mixture between silicic acid and CdS nanoparticles was homogenized by addition of acetone and rigorous magnetic stirring. Prepared mixture was kept for 24 h to evaporation of acetone. Subsequent to this step, the obtained fine powder heated at 50°C for the complete removal of acetone. After this, as-obtained fine power heated in step wise pattern. For each step powder heated at 200, 400, 600, 800, and 1000 °C in vacuum for three hours. In this fashion, we prepared five samples of CdS loaded SiO_2 rich composite

The physic-chemical analysis of prepared samples was done through various analytical tools. The structural study of samples was completed using X-ray diffraction (XRD) analysis on XRD (Philips PW 1830). The surface study of composites was completed using field emission-scanning electron microscope (FE-SEM) images, which captured by using JEOL JSM-7500F. For optical study of sample, The photovoltaic cell for the study was prepared by simple doctor blade method. In this fabrication process, ITO plates were used as transparent electrode whereas aluminum foil was used as metallic electrode. As-prepared sample was sandwiched between ITO and aluminum. The diode parameters of photovoltaic cell were checked in dark conditions.

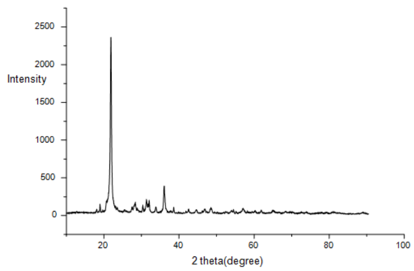

Fig.1.XRD patern of CdS/Si nanocomposite

Figure.2.show a SEM images of CdS incorporated SiO_2 nanocomposites. SEM micrograph show that as-prepared composite have smooth surface morphology. Small nano-sized grains clearly indicated their nanocrystalline nature. The average particle size estimated using SEM analysis is in good agreement with XRD analysis.

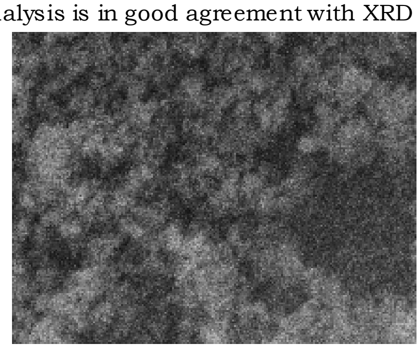

Fig.2. FE-SEM image of CdS/Si nanocomposite

Fig.3 shows the I-V characteristics of as-fabricated PV cell, studied at room temperature (303 K). The light source (Incandescent light) was used to check the performance of PV cells. The various PV cell parameters such as (V_{OC}), short circuit current (I_{SC}), fill factor (FF), and power conversion efficiency (η) calculated for 15 wt.% CdS loaded SiO_2 composite.

Fill factor (FF) gives the idea about the maximum power to the theoretical power, which would be

The data of diode parameters such as short circuit current (I_{SC}), open circuit voltage (V_{OC}), fill factor (FF), and power conversion efficiency (η) were tested under incandescent light bulb.

Results and Discussion

Figure 1 shows the XRD pattern of CdS incorporated SiO_2 nanocomposite. XRD pattern clearly shows the presence of characteristics peaks of CdS with correct diffraction peak position and marginal intensity. The signatures peaks of CdS exactly match with JCPDS card No: 06-0464. The broad hump with some shoulder peak appears between 25-35 ° indicates the presence of SiO_2 in composites. It reveals that CdS/Si nanocomposite is crystalline in nature.

extracted from PV cell at both the open circuit voltage and short circuit current condition. The FF of PV cell was estimated using Eq (1) [10],

$$FF = \frac{I_{MAX} \times V_{MAX}}{I_{SC} \times V_{OC}} \quad (1)$$

The power conversion efficiency (η) of PV cell determined using Eq (2) [11],

$$\%\eta = \left(\frac{I_{SC} \times V_{OC} \times FF}{P_{in}} \right) \times 100 \quad (2)$$

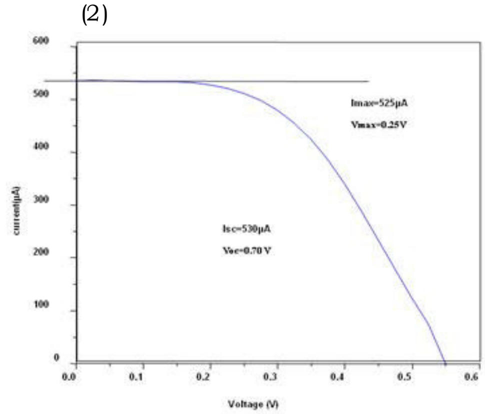

Fig.3.I-V characteristics of CdS/Si fabricated PV cell

Conclusions

In this study, we successfully demonstrated the preparation of CdS incorporated SiO_2 nanocomposite by simple solid state diffusion method. Silicic acid ably works as source of silicon in the process of solid state diffusion. IV characteristics of PV cell results power conversion efficiency of 1.26 % which was extracted from 15 wt.% of CdS loaded SiO_2 composite, whereas fill factor was found to be 0.354.

References

Z.S.Yang, C.Y.Chen, P.Roy, H.T.Chang (2011) "Quantum dot sensitized solar cells incorporatingnanomaterials",Chem.commun .47(9561-9571)

P.V.Kamat,(2008)"Quantum dot solar cells. semiconductor nanocrystals as light harvesters", j.phys.chem, c 112(18737-18753)

W.T.Sun, Y.Yu, H.Y.Pan, X.F.Gao, Q.Chen, L.M.Peng, (2008) "CdS quantum dots sensitized TiO2 nanotube array photoelectrodes",J.Am chem. Soc, 130 (1124-1132)

J.Z.Zhang, N.K.Shrestha, P.Schmuki,(2010) "Self–organized CdS microstructures by anodization od Cd in chloride containing Na_2S solution", Electrochimica Acta, 55(7766-7771)

Chuan He, Chang Buo, Han Yu, Rui, Jian Li, (2011) "photovoltaic effect of CdS/Si nanoheterojunction array", journal of applied physics,110(94316)

Yong Li, Xiao Yan Song, Yue Li Song, (2015)" characterization of electronic structures from CdS/Si nanoheterostructure array based on silicon nonporous pillar array",materresbull, 74(507-510)

A.S.Obaid, Z.Hassan, M.A.Mahdi, M.Bououdina (2013) "Fabrication and characterization od n-CdS/p-PbS heterojunction solar cells using microwave –assisted chemical bath deposition",solar energy, 89(143-151)

J.S.Jie, W.J.Zhang, Y.Jiang,X.M.Meng (2006)"photoconductive characteristics of single-crystal CdS nanoribbons",Nano let.6(1887-1892)

G.Z.Shen, J.H.Cho,J.K.Yoo, (2005)" synthesis of single crystal CdSmicrobelts using a modified thermal evaporation method and their photoluminescence",j.phys.Chem.B 109(9294-9298)

T. Salmi, M. Bouzguenda, A. Gastli, A. Masmoudi,(2012) "MATLAB/simulink based modelling of solar photovoltaic cell", International Journal of Renewable Energy Research, 2 (213-218)

M. Seifi, A. Soh, N. Izzrib. A. Wahab, M.K.B. Hassan,(2013) "A Comparative Study of PV Models in Matlab/Simulink", International Journal of Electrical, Robotics, Electronics and Communications Engineering, 7 (97-102)