Novel solid state solar cell made from n-cu_2o using Bamboo Powder active carbon as upper - electrode

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Abstract— *Bamboo is a natural vegetable fibre. They are widely distributed throughout parts of the world, particularly in the Asia-Pacific region. Activated carbon was prepared by one step pyrolysis by treating with 0.1M KOH of scoured bamboo ball billed micro particles at 350^{0}C heat rate of 10 cm^{-1} in the nitrogen atmosphere for 0.15h. Iodine number was determined to acid washed all carbon sample. Powder activated carbon was characterized with SEM. The copper plate was fabricated by using a thin film of Cu_2O which is formed by boiling (5*10^{-3}M) solution of copper sulphate for 60 min. After a solid state photovoltaic cell Cu/n-Cu_2O/BPAC/ITO were made have BPAC acts as the upper electrode of the solid state solar cells.it was formed that n-Cu_2O / BPAC contact forme schottky barrier junction to separate photo generated charge carriers, forming a solid state photovoltaic device. UV Absorption spectra, FTIR spectra. V- I characteristics and photocurrent development with time were used to compare photovoltaic characteristics of solid state thin film solar cell from this study.*

Keywords—**Bamboo, thin film solar cell, Ball mill**

I. INTRODUCTION

This d Bamboos are a diverse and primitive group of perennial plants in the true grass family. They are widely distributed throughout parts of the world, particularly in the Asia-Pacific region. It grows primarily in tropical and subtropical areas but several species grow in temperate areas. There are approximately 2000 species worldwide.

Bamboo charcoal contains many pores and gaps in the structure, making it excellent for adsorption [1-2]. Carbon materials have been widely used as electrode substrates to make various electrodes. [3-4] Cu_2O ideal raw material for making n-type semi-conductor devices [5]. Layer of Cu_2O can be easily produced in using purify Cu plate immerse in $CuSO_4$ (aq) solution, when very in thermal condition of $CuSO_4$ (aq) solution [6]. This paper reports the findings of the development of a solid state thin film solar cell, based on activated carbon derived from lingo-cellulosic fibres (Bamboo), which act as an upper electrode on the n-Cu_2O. In this work, Potassium Hydroxide (KOH) chemical activation one step pyrolysis methods were used to activate the Raw Bamboo fibre. Diffused reflectance Spectra, FTIR spectra. V-I Characteristics and the photocurrent stability of the cell were measured to compare the effectiveness of the solid state thin film solar cells, based on activated carbon derived from Bamboo fibres.

¡¡. METHODOLOGY

Materials

Green bamboo was collected from a hill side in Sri lanka. The sample were cut into small sticks, then soaked in tank for 2 weeks, after retting, the samples were crushed to fibre stage and combed.

Methods

Activated carbon were prepared by one step pyrolysis by chemical treatment with 0.1 M of Potassium Hydroxide (KOH) of raw bamboo fibres particles at 350 ^{0}C heat rate of 20 ^{0}C min^{-1} in nitrogen atmosphere for 0.15h.after wash with 0.01MHCl for 1hour. Before heat treatment raw fiber

were scoured (alkaline-bio) thoroughly and ultrasonically wash with distill water to remove unwanted chemical and dried at 80 ^{0}C in electrical muffle oven for 5 h. raw fibre micro level particles were produced by using ball mill machine. It ran at (290- 300) rpm for 10 minutes. Bamboo particles were leach with 0 .5 M KOH for 0 .45 hrs. After bamboo pulp were filtered and separated.

Production step of Cu/ n-Cu_2O/CGAC/ITO and Cu/ n-Cu_2O/BGAC/ITO photo electrode

Manually well clean purity Copper plate (1 x 4 cm^2) was immersed in 5 x 10^{-3} M $CuSO_4$ solution at 540 ^{0}C for 60 min. After boilling, a layer of Cu_2O formed on the copper plate. Cu/n-Cu_2O photo electrode were washed with distilled water and dried and were stored in waterless place.

After fabricating Cu/n-Cu_2O,a thin layer of Bamboo powder active carbon BPAC were placed on Cu/n-Cu_2O to form Cu/n-Cu_2O/BPAC/ITO solid state photovoltaic cell, by placing ITO conductive glass plate on Cu/n-Cu_2O/PAC as configuration 1.

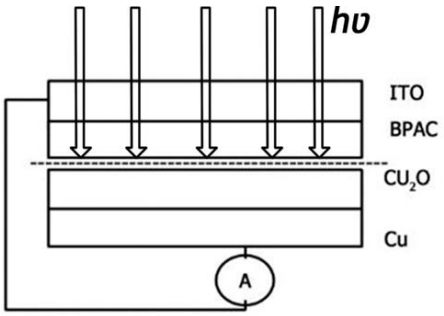

Figure 1: Schematic presentation of the thin film photovoltaic device structure: CU/ n-CU_2O/BGAC/ITO

Experimental techniques

Raw fibre were grounded by using ball mill machine (Model: Fritsch supreme line Pulverisette 7). Ultra-sonic heat Barth was used to fibre cleaning process. (Model: Rocker Soner 203H).Absorption properties were determined by Shimdzu 1800 UV Spectrophotometer .FTIR study was carried out on Shimdzu IRAffinity-1S FTIR Spectrophotometer, using potassium bromide(KBr) pellet. A 100W tungsten filament lamp and water circulated Perspex cell was used to cut off the IR radiation of the tungsten lamp.

¡¡¡ .RESULTS AND DISCUSSION

Characterization of BPAC

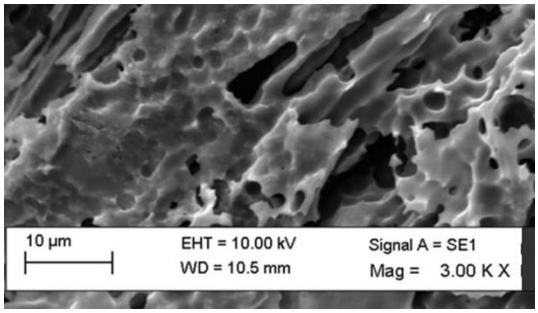

Figure 2: Micrograph of surface of bamboo activated carbon by washing time for 60 min in 0.1M HCl solution.

Figure 2 show SEM micrograph of clean BPA ,though the micrograph irregular and porous surface activated carbon could be observed, on the this fact ,it can be concluded that BPAC presents the adequate morphology characteristics for sample washed with 0.01MHCl for1h.EDS results demonstrate that element such as carbon (99.62 %) contain.

Fourier-transform infrared (FTIR) spectroscopy of Cu/n-Cu_2O

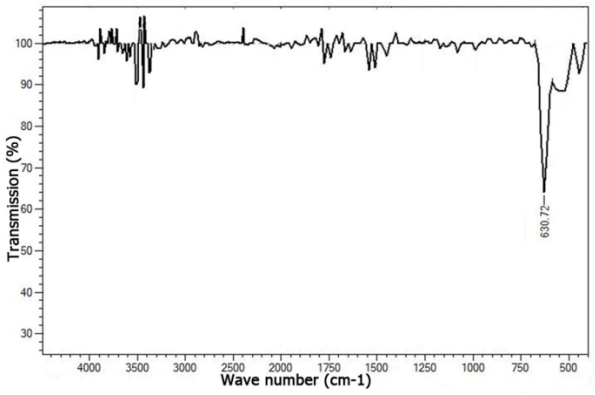

Figure 3: shows the FTIR spectrum of surface of Cu_2 O layer

Figure 3 shows the FTIR spectrum of surface of Cu_2 O layer on copper plate by boiling time for 60 min copper sulphate solution.as shown in Figure3, displays an absorption peak at around 630.72 cm^{-1} , which can be attributed to the Cu (I)-O vibration. The present FTIR spectrum is well consistent with that of Cu_2 O. In its crystal lattice, Cu_2 O is connected to two oxygen atoms in a linear coordination, this was clearly seen in FTIR spectroscopy

Diffuse reflectance spectra

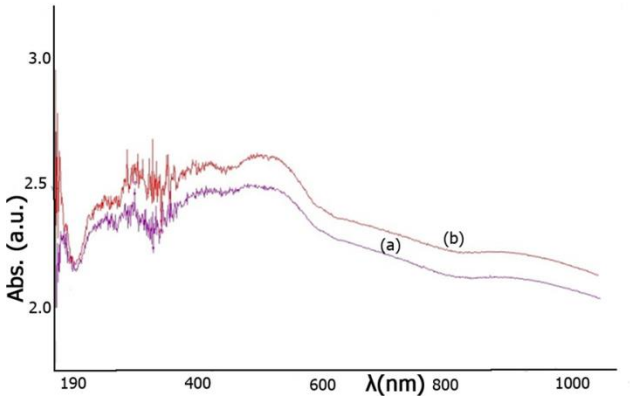

Figure 4: Diffuse reflectance spectra Cu/nCu_2O (a) fabricated with BPAC 2mgcm^{-2} (b) fabricated with BPAC 1mgcm^{-2}

Figure 4 shows the diffused reflectance spectra of two tested samples. The shapes of the curves are found to be related to each other. Curve (a) of figure 11 shows the diffuse reflectance spectra of the Cu/n-Cu_2O/ITO photo electrode. Adsorption edge corresponding to light adsorption of n-Cu_2O (λ≈620nm band gap =1.9ev).Curve (b) of figure 4 shows the diffuse reflectance spectra of Cu/n-Cu_2O/BPAC/ITO .bamboo activated carbon deposited successfully on Cu_2O layer. The bad gap estimated from λ≈620nm band gap =2.2ev can be observed. BPAC was collected by optical charge carriers which help rise of absorbency level of n-Cu_2O film at the solid state.

The time development of the photocurrent

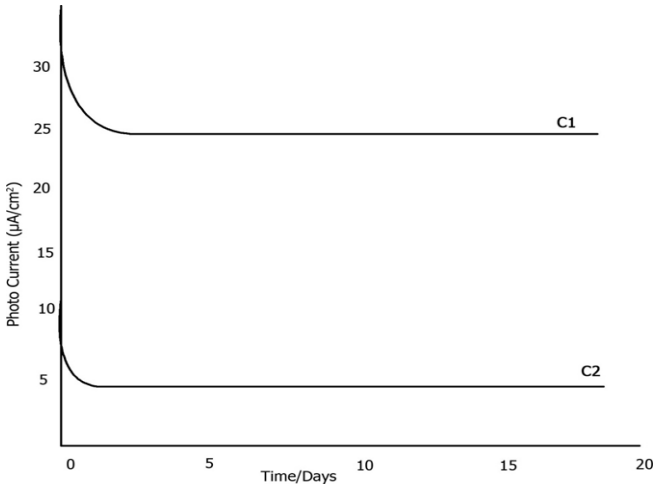

Figure 5- Photocurrent development with the curve of Cu/n-Cu_2O/BPAC/ITO for 20 days (C1) Fabricated with BPAC of 1mgcm^{-2} (C2) Fabricated with BPAC of 2mgcm^{-2}

Figure 5 shows the time development of the photocurrent for Cu/n-Cu_2O/BGAC solid state cell for different BPAC concentration Stable photocurrent were observed for each cell at different BPAC concentration The best concentration of BPAC was found at 1mg cm^{-2} for the solid state device. When the BPAC concentration increases father the steady state photocurrent decreases gradually may be due to the incident light cut off for n-Cu_2O.

The photocurrent generation at Cu/n-Cu_2O/BGAC/ITO can describe as follows. Solid state photovoltaic device Cu/n-Cu_2O/ITO prepared in without BPAC, any photocurrent observed due to light adsorption. Still only after sandwiching BPAC to form Cu/n-Cu_2O/BGAC junction device, photocurrent was observation can be explained as following mechanism. Carbon pore structure helps to move the excited electrons from BGAC to n-Cu_2O layer to separate photo-generated after absorbing the visible light. So that the recombination of photo-generated charge carries is suppressed. Carbon particles highly penetrated in the n-Cu_2O layer can act as collection centres to transfer the photo-generated carries into the circuit to flow the photocurrent .This proves that the BGAC were serving as a upper electrode for this exacting photovoltaic cells. It should be mention that maximum Power conversion efficiency reach is nearly 1% for BGAC concentration of 1mg cm^{-2} Cu/n-Cu_2O/BPAC/ITO junction photo electrode and minimum Power conversion efficiency reach is nearly 0.8% for BGAC concentration of 2mg cm^{-2} Cu/n-Cu_2O/ITO junction photo electrode.

Iv. CONCLUSION

A solid state thin film photovoltaic cell produced with BGAC and Cu/n-Cu_2O for the first time. The photocurrent development was observed in Cu/n-Cu_2O/BPAC/ITO compared with Cu/n-Cu_2O/ITO photo electrodes. The photocurrent increases. When the contact between Cu/n-Cu_2O and ITO was increased and it serves as upper electrode. Remarkable stability was observed in Cu/n-Cu_2O/BGAC solid state photovoltaic cell.

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ACKNOWLEDGMENT

The authors gratefully acknowledge support for this work from the National Research Council of Sri Lanka (NRC), National Science Foundation (NSF) of Sri lanka.The authors would like to thank prof. P.Samarasekara for many fruitful conversations.