# Novel solid state solar cell made from n-cu₂o using granular active carbon as upper - electrode

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**Abstract**— *Coir is a natural vegetable fibre obtained from the coconut tree. In this research, alkaline-bio scoured bristle coir fibres powders were subjected to alkaline activation method. Potassium Hydroxide (0.1M) was used to treat the carbon powder subjecting it to activation. The coir carbon powder was fed into a tube furnace with a constant heating rate of 20C$^o$ min$^{-1}$ until the temperature reached different temperatures between 380 $^o$C to 450 $^o$C. At a selected temperature between 380C$^o$ to 450C$^o$ the samples were kept inside the tube furnace for 15 min in a nitrogen flow. Subsequently they were cooled up to room temperature. Then determine iodine number. Copper plate was fabricated by thin film of $Cu_2O$ .which is formed by well boil (5*10$^{-3}$M) solution of copper sulphate and make in n-$Cu_2O$ solar cell. n- $Cu_2O$ band gap was about 2.2eV.Coir active carbon powder (GAC) act as an upper electrode of this specific photo electrode. The diffused reflectance spectra and the X-ray diffraction peak (XRD) and SEM the cell were measured to determine the effectiveness of the solid state thin film solar cell. A significant variation in photo current occurred by stability of GAC is clearly observed in the upper electrode with the thin film and conductive glass plate solar cell*

**Keywords**— *Coir, Activated carbon, thin film solar cell*

## I. INTRODUCTION

Coir is a natural vegetable fibre obtained from the coconut tree. The porous structure of coir found in the lacuna region offers an attractive proposition for producing activated carbon. Alkaline- bio scouring of coir fibre improves the porosity level by removing all type of hydrophobic matters present in the coir fibre.[ 1-2] The abundance and availability of coir fibre in Sri Lanka makes them good sources of raw materials for activated carbon production. Activated carbon obtained from lingo-cellulosic materials has the advantage of offering an effective, low cost replacement for non-renewable coal-based Granular Activated Carbons (GAC) provided that they have similar or better adsorption efficiency [3]. The electrical conductivity is also most important physical property for the other application of carbon, such as their use in electrodes & electrode additives [4-5]. Porous structure of carbon material serves as counter electrode and enhances the catalytic and electrical conductivity [6]. Finding of developments of n-$Cu_2O$ thin film solar cells research have been carried out base on eco-friendly & low cost applications [7-8]. This paper reports the findings of the development of a solid state thin film solar cell, based on activated carbon derived from coir fibres, act as an upper electrode on the n-$Cu_2O$. In this experiment, Potassium Hydroxide (KOH) chemical activation method was used to activate the bristle coir fibre. Finally the diffused reflectance spectra and the photocurrent stability of the cell were measured to determine the effectiveness of the solid state thin film solar cell, based on activated carbon derived from coir fibres.

## II. METHODOLOGY

### *A. Materials*

The bristle coir fibres were scoured in solution of 0.15M of NaOH with added pectin of (2g) and Teepol (2g) dissolved in 800 ml of water. The temperature was maintained at 45$^0$C. The liquor ratio was maintained at 1:50 and the pH level at 9.2. Thirty minutes after the scouring treatment the fibre were washed with distilled water and dried at 100$^0$C for three hours and were stored in desiccators. A sample of a scoured bristle coir fibre weighing 10g was subject to Ball Mill machine. (Model: Fritsch supreme line Pulverisette 7). it run at 600 rpm for 10 min to produce coir micro level particles.

### *B. Methods*

Then 0.1M of Potassium Hydroxide (KOH) was used to treat the coir particles subjecting it to activation. After this the coir particles was fed into a tube furnace with a constant heating rate of 20C$^o$ min$^{-1}$ until the temperature reached a range between 380 $^o$C to 450 $^o$C. At a selected temperature between 380C$^o$ to 450C$^o$ the samples were kept inside the tube furnace for 15min subjected to a nitrogen flow.

After activation, the mixture was removed from the furnace and allowed to cool to room temperature. In order to determine the activity level of the coir carbon, Iodine number was determined according to the standard test method ASTM D 4607.

*1) Production step of Glass*/ITO/GAC/ n-CU2O /CU *photo electrode*

Copper plates were cleaned by water shine paper and polished until a mirror like surface. Copper plate ($1*4cm^2$) was immersed in ($5 \times 10^{-3}$) M $CuSO_4$ boiled solution. The temperature was maintained at $540^0C$. The volume was maintained at 100ml .sixty minutes after form $Cu_2O$ layer. Cu/n-$Cu_2O$ photo electrode were washed with distilled water and dried and were stored in desiccators.[2]

Solar cell were prepared for measurement of surface area by piling a small amount on a layer of carbon powder (GAC), after that samples of powder was spread into a thin uniform layer using a glass rod. Conducting glass plate was fitted on top of GAC layer photo electrode as illustrate in Figure 1

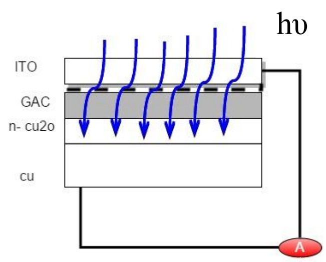



Figure. 1. Schematic presentation of the thin film photovoltaic device structure: glass/ITO/GAC/ n-CU2O /CU

*2) Experimental techniques*

Absorption properties were determined by Shimdzu 1800 UV Spectrophotometer. .morphological characteristics were determine by SEM(Model). Stability were determined by using following instrument 100w turnstone incandesce lamp,water tabulate water cell

## III. RESULTS AND DISCUSSION

*A. Diffuse reflectance spectra*

Figure 2 show the diffused reflectance spectra of sample ( a) and sample(b) .the shapes of the curves are found to similar to each other. That no electrical impulse have been generated by fabricated with GAC layer on n-$Cu_2O$.band gap energy was around 2.2eV ($\lambda \approx$ 640nm).GAC was accumulated by optical charge carriers .which is help for increment of absorbency level of n-$Cu_2O$ film at the solid state.

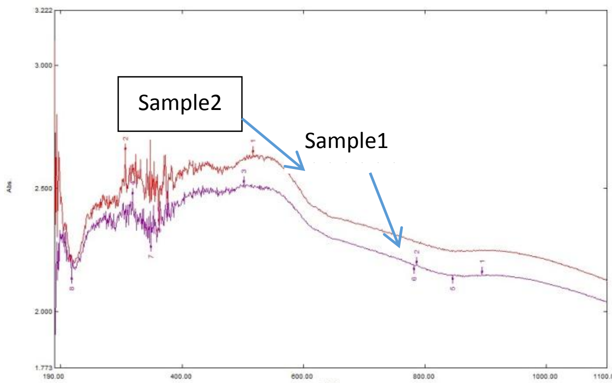



Figure 2. *Diffuse reflectance spectra* Cu/n$Cu_2O$/GAC/ITO/Glass

*B. X-ray diffraction spectra (XRD)*

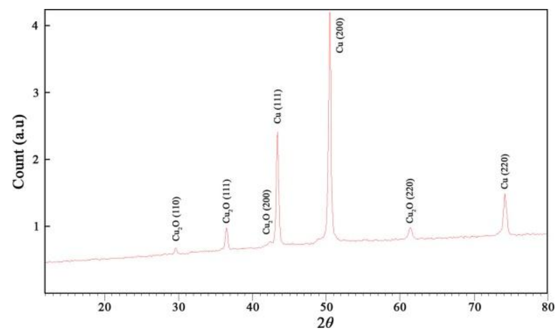



Figure 3. *XRD spectra of $Cu_2o$ formed*

Fig .3 show the XRD spectra found for copper layer with boiling time of 60 min.The XRD spectra is conquered by characteristic strong peak ,(110),(200) and (220) $cm^{-1}$ from the n-$Cu_2o$ semi conductor. The at 60 min reflection become stronger and a $cu_2o$ (200) peak also appears next to the cu (111) .these result show that both the thickness and crystallinity of the $cu_2o$ layer growth with long time duration boiling of Cu plates in $cuso_4$ solution.

*C. Scanning electronic micrography*

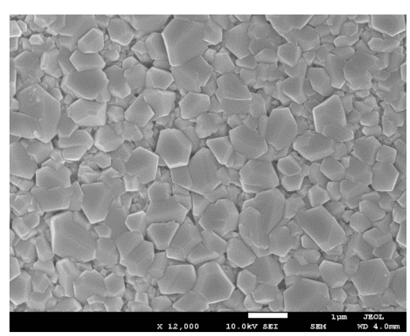
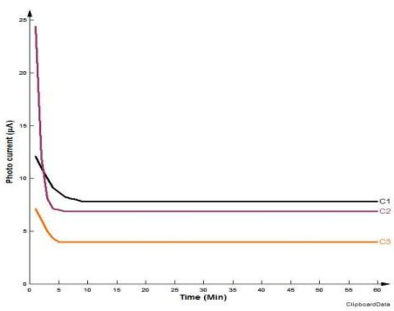


Figure. 4.. *Micrograph of* surface of $Cu_2O$ layer on copper plate

The surface of $Cu_2O$ layer on copper plate were observed using scanning electron microscope (SEM).Although the well –packed $Cu_2O$ film are visible ,the micrograph enable the shape and the location of crystal on the surface of the $Cu_2O$ to be observed

Referring to Figure .it was seen formation of crystallites with size of -10µm .father hardening in air at temperatures in excess of $400^0$ C does not show any major changes of grain sizes or improvements of XRD patterns.

*D. stability t of upper electrode*




Curve are found to have photo current stability regions of tree sample of activated carbon upper electrode observed in as show in fig (3) for activated carbon layer ,different amount of activated carbon fabricated sample show an photo current response. The photo current degradation is significant above sample. Maximum photo current were observed at 24.1µA

## IV. CONCLUSION

Activated carbons were prepared from the pyrolysis of coir Bristol fibre at 450 and 400°C by chemical activation of KOH. The surface Area of the activated carbons produced by chemical activation was found to be higher than untreated carbon. The properties of the activated carbon produced in this research such as surface area ability to increasing pore structure. It had an improved photo –current of solar cell. Consequently, the activated carbons produced from lingo-cellulosic such as coir Bristol material can be used as upper electrode for n-$CU_2O$ /CU photo electrode for first time.

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