Ministry of Education
Department of Higher Education
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# Pyay University Research Journal

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## Editorial Board

# Investigation to Improve the Properties of Construction Materials from Nattallin Township Applying Bamboo-Fibres

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## Abstract

Elementary concentrations and mechanical properties of currently used local bricks from Nattalin township, Pyay district, Bago division were investigated by using EDXRF technique, XRD technique and compressive testing machine, bending testing machine and tensile strength testing machine. In order to obtain the more quantities, layers of bamboo-fibre were inserted in the brick with distinct positions. Then the properties of newly created bricks were measured. It is intended to be able to use the quality construction materials for the benefit of the nation by using the acquired out - coming knowledge and data investigated from this research.

**Key words : EDXRF, XRD, compressive strength, bending strength**

## Introduction

In the Pyay District, people are using the traditional bricks which are made by the mud and chaff with paddy shell in construction of buildings. Bricks from that region are recognized and used widely due to their fair compressive strength. In the present research work, bamboo-fibres layers are introduced by inserting them in bricks  and then the characteristic changes of prepared bricks comparing to the conventional bricks are investigated. From this research, the mechanical properties of those bricks such as the compressive strength and the flexible strength can be expected to develop and so to give more compressing resiliency from the effects caused by weather as well as the earthquake.

## Bamboo-Fibres

A bamboo is one of the forest based oldest raw materials used by the paper industry, a little work has been carried out on its biopulping to improve the yield as well as fibre characteristics. Bamboo is a perennial, giant, woody grass belonging to the group angiosperms. Most of the bamboos need a warm climate, abundant moisture and productive soil, though some do grow in reasonably cold weather.  They grow in plains, hilly and high altitude mountainous regions and in most kinds of soils, except alkaline-soils, desert, and marsh.There are about more than 70 genera and overall 1200 species of bamboo worldwide.  In distinction to its name, bamboos are classified under the subfamily.

The mechanical properties of bamboo have been studied as follow.  The vascular bundle size and fibre length correlated positively with modulus of elasticity (MOE) and stress at proportional limit. The increase in the size and the length of fibre could be accompanied by an increase in strength property. The fibre wall thickness correlates positively with compression strength and MOE but negatively with modulus of rupture (MOR).

HmyinWa become the best special interest bamboo fibre in this research. This bamboo-fibrewere obtained from the Nattalindownship, Pyay District.In this work, mud and chaff were used as raw materials to make brick samples and they were examined by EDXRF and XRD methods at Universities Research Centre, Yangon.

And then, the compressive strength and bending strength of brick sample were determined by compressive strength testing machine (RBU-250) and the bending strength

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universal testing machine (UPM-4) from the structural laboratory at department of civil engineering in Yangon Technology University.

**Experimental Procedure**

A ditch of mud having volume with dimensions is $5' \times 5' \times 1'$ from Nattalin, Pyay district was thoroughly mixed with a bushel of paddy shell and kept for a night. In the morning it was mixed again with a bushel of paddy shell to prepare the soil. That soil was tested by EDXRF and XRD.

Thickness of bamboo-fibres applied for the research is about $0.0394''$. To obtain the proper bricks for measuring the compressive strength, binding strength and tensile strength three different types of moulds with dimensions $9.14'' \times 4.4'' \times 1.57''$, $14'' \times 4'' \times 4''$ and $18'' \times 1'' \times 1''$ are respectively used.

To investigate the compressive strength, the soil was transformed to $9.14'' \times 4.4'' \times 1.57''$ bricks using mould. Five bricks were taken as a non-layer sample bricks. Next, bamboo-fibres which want to be used to make layer-bricks were sandwiched between soil in the mould so as to from alternate layers of bamboo-fibres and soil. In this way, bricks containing one layer of bamboo-fibres, two layers of bamboo-fibres and three layers of bamboo- fibres each for five bricks were made. The sample bricks, both the non-layer bricks and layer bricks, were heated in the sun for 15 days, and baked in the wood fire for 3 to 5 days. The sample bricks were then ready to be tested.

Figure 1 Soil preparing mixed with paddy shell

Figure 2 Bamboo- fibres with required measurements

Figure 3 Threemoulds with required measurements

Figure 4 Bricks for measuring the compressive strength

Figure 5 Compressive testing machine

To measure the bending strength, five more bricks with 14″× 4″× 4″ measurement were made. With that measurement, 5 one layer of bamboo-fibres and 5 two layers of that and 5 three layers of that were made too. The bending strengths of them were measured.

Figure 6  Bricks for measuring the bending strength

Figure 7  Bending testing machine

To measure the tensile strength, the fifteen bricks with 18″× 1″× 1″measurements were made. With that measurement, one layer, two layers and three layers of bamboo-fibres were used in each five of bricks. The tensile strength could not be measured because they were damaged when they were heated and baked.

Figure 8  Damaging bricks for measuring the tensile strength

## Experimental Results

### EDXRF Result

Fine powder of mud was obtained from dried natural mud under the sunshine. Then the dried powder was made pellet at Universities Research Center (URC) and named $N_1$.

Furthermore, the natural mud and paddy shell were mixed thoroughly and the mixture was dried. The well dried mixture was made pellet at URC and also named $N_2$.

The two samples $N_1$ and $N_2$ were investigated by Energy Dispersive X-Ray Fluorescence Spectroscopy (EDXRF) to study the contents in the samples. Figures 9 and 10 showed the results of the EDXRF patterns. And also the concentrations of elements in sample $N_1$ and $N_2$ are shown in Table 1.

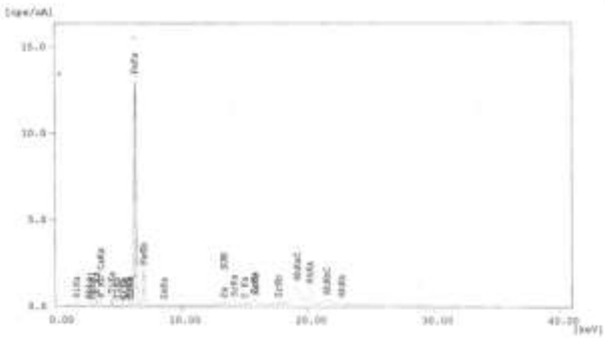

Figure 9 EDXRF pattern for sample $N_1$

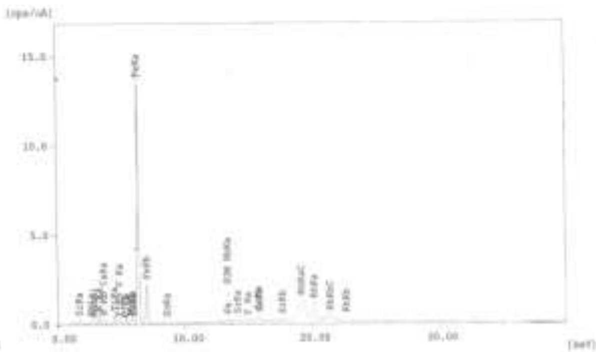

Figure 10 EDXRF pattern for sample $N_2$

**Table 1 Elements Concentrations for Samples $N_1$ and $N_2$**

| Element | Sample $N_1$ | Sample $N_2$ |
|---|---|---|
| Si | 48.095% | 48.812% |
| Fe | 37.340% | 36.242% |
| K | 8.502% | 8.500% |
| Ti | 2.655% | 2.740% |
| Ca | 2.109% | 2.209% |
| Mn | 0.396% | 0.574% |
| Zr | 0.306% | 0.319% |
| Cr | 0.235% | 0.127% |
| Sr | 0.189% | 0.167% |
| Zn | 0.114% | 0.130% |
| Y | 0.059% | 0.059% |
| Rb | - | 0.044% |

## XRD Result

Pelleted samples $N_1$ and $N_2$ were analyzed by XRD technique and the results were examined with standard library file for XRD to study the content of silicon dioxide $SiO_2$ and aluminum oxide $Al_2O_3$ that are properties of cement. The results were shown in Figure 11 and Figure 12 and their properties were shown in Table 2 respectively.

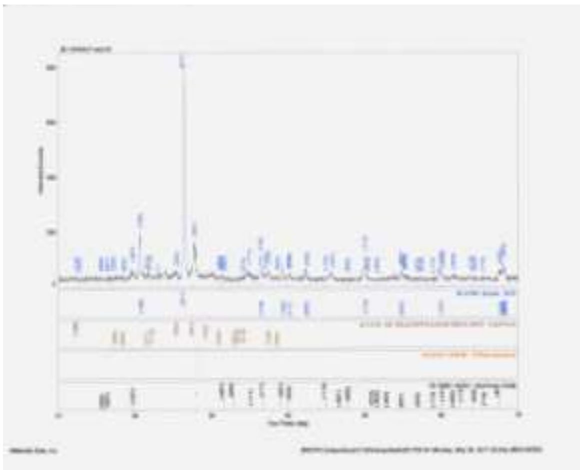

Figure 11 XRD result of $N_1$

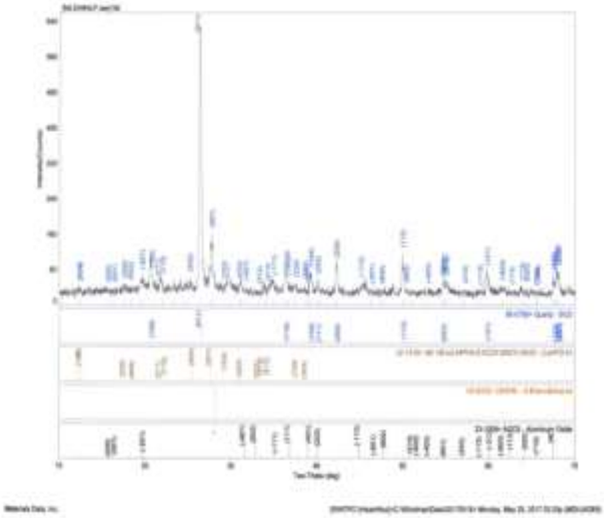

Figure 12 XRD result of $N_2$

**Table 2 XRD Results for Samples $N_1$ and $N_2$**

| | Plane | |
|---|---|---|
| | $N_1$ | $N_2$ |
| $SiO_2$ | (112),(011),(100) | (112),(011),(102),(100) |
| $Al_2O_3$ | (403),(202),(111),(-201) | (403),(-403),(-601),(202),(111), (-201) |

## Measuring the Compressive Strength and the Bending Strength

The bricks which had been made according the required of machine were measuring their compressive strength and bending strength from the structural laboratory at depatrment of civil engineering in Yangon Techonology University. These results are shown in Table 3.

**Table 3 Results for Compressive Strength and Bending Strength.**

| | None Layer | One Layer | Two Layers | Three Layers |
|---|---|---|---|---|
| Compressive Strength (psi) | 1983 | 2136 | 2362 | 992 |
| | 2070 | 2273 | 2463 | 2153 |
| | 2117 | 2375 | 2487 | 2225 |
| | 2367 | 2557 | 2499 | 2428 |
| | 2673 | 2621 | 2539 | 2621 |
| **Average (psi)** | **2242** | **2392.4** | **2470** | **2083.8** |
| Bending Strength (psi) | 434.6 | 453.5 | 459.3 | 427.3 |
| | 437.35 | 597.0 | 558.7 | 507.5 |
| | 568.2 | 610.8 | 609.8 | 598.0 |
| | 591.5 | 638.2 | 641.9 | 607.7 |
| | 630.1 | 788.5 | 698.8 | 629.6 |
| **Average (psi)** | **532.35** | **617.6** | **593.7** | **554.02** |

## Discussions and Conclusion

### Discussions

According to EDXRF, results show that Si contains the highest concentration of 48.095% in $N_1$ and 48.812% in $N_2$. Rb elements does not contain in the natural mud but it contains in the mixture of paddy shell and mud.

The XRD results show that in sample $N_1$, the plane (112) , (011) and (100) identify with the planes of sample $N_2$. But the plane (102) can be seen in the sample $N_2$ only. All of the planes can be attributed to silicate ($SiO_2$) phase which is matched well with the library file.The planes in sample $N_1$ and $N_2$ which (403) , (202) , (-111) and (-201) identify with the planes in $Al_2O_3$ from the library file in XRD. But the planes (-403) and (-601) can be seen in sample $N_2$ only.The plane (011) proves that the silicate ($SiO_2$) is the major phase of sample $N_1$ and $N_2$.

The measurements of compressive strengths and bending strengths of all sorts of bricks are collectively summarized in Table 3. According to the five conventional bricks, without Hmyin Wa fibre layers and currently used in Nattalin of Pyay District, the average compressive strength is 2242 psi. But when one layer, two layers and three layers of bamboo-fibres are inserted into the bricks,the values alter and are found to be 2392.4 psi, 2470 psi and 2083.8 psi respectively.

The average bending strengths of five bricks in each for non-layer, one layer, two layers and three layers of bamboo-fibres are measured to be 532.35 psi, 617.6 psi, 593.7 psi and 554.02 psi respectively.

### Conclusion

The EDXRF results show that the natural mud from Nattalin Township, Pyay Distict, Si and Fe contain the highest values of concentration. When the natural mud was mixed with the paddy shell, their consisted values are not changed mostly. But Rb elements detect in this Rubidium elements have the properties of to move traces of oxygen from the materials.

From the XRD results, the natural mud from Nattalinn Twonship which were made by the bricks have the properties of cement.

The average value of compressive strength of brick samples which were made by the mixture of natural mud and paddy shell without inserting bamboo fibre is 2242 psi. This value is very agree with the standard values (1000-2500 psi). So that conventional bricks currently used in Nattalin township is safe in construction. When the bamboo- fibres of one and two layers were insteaded in bricks the compressive strength are increasing to 2392.4 psi and 2470 psi respectively. For the three layers of bamboo-fibres,it is 2083.8 psi.

The observation is shown in the Figure 13.

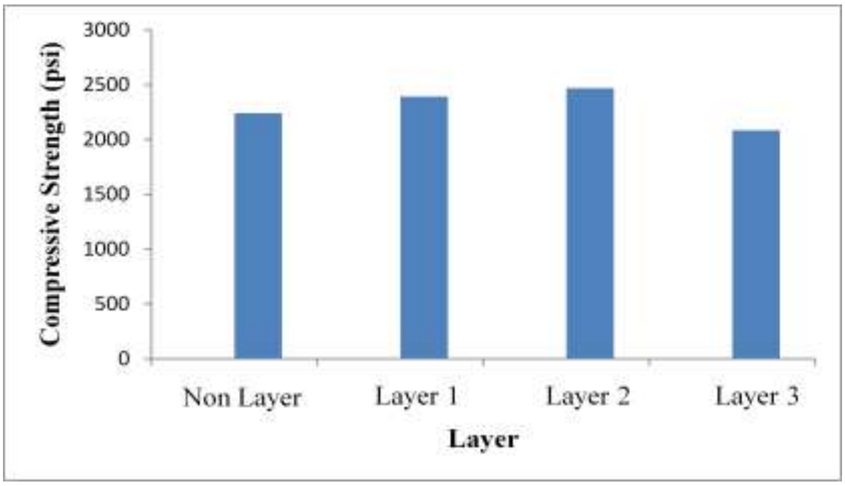


Figure 13 Compressive strength vs. layer

The average bending strength of 5 bricks without bamboo-fibres is 532.35 psi. When the one and the two layers of bamboo-fibres were inserted into traditional bricks, the average bending strength are increasing to 617.6 psi, 593.7 psi. When inserting three layers, the value is decreasing to 554.02 psi but more than the original values. The detection is shown as the graph in Figure 14.

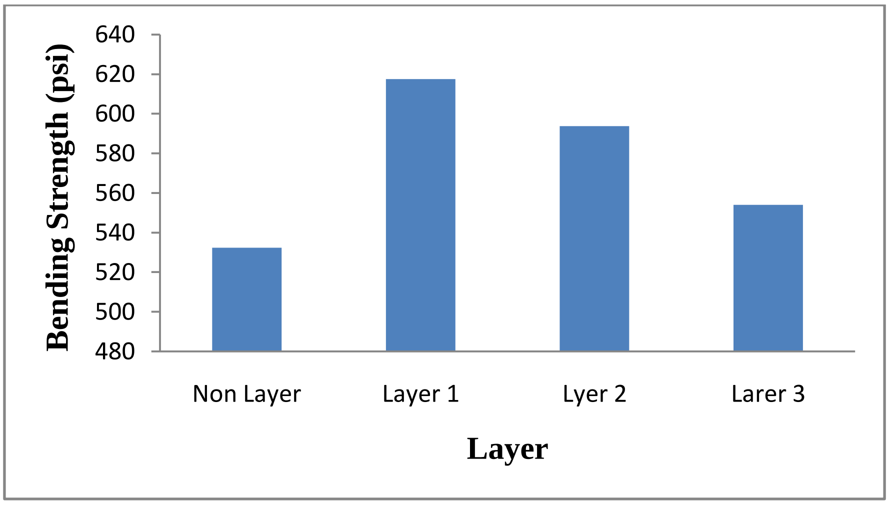


Figure 14 Bending strength vs. layer

From the above mentional results, this research can be concluded that, the bamboo-fibres are the appropriate additive to prepare bricks with higher compressive strength and bending strength but not more than two layers.

And also it can be concluded that, the present work has primarily been focused upon the compressive strength and the bending strength that will be supported for further studies concerning the environmental safety and protecting the building from damaging by the natural disasters such as earthquakes, storm, land-slide, etc.

**Acknowledgements**

We wish to express our sincere thanks to Dr Aung Aung Min, the Acting Rector of Pyay University, DrThwe Linn Ko, Pro- Rector of Pyay University and Professor Dr Soe Soe Nwe, Head of Department of Physics, Pyay University, for their kind permission to carry out this work.

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# Study on the Efficiency of $TiO_2$ based DSSC Solar Cell with Different Dyes

Tun Lin Htet[1], LwinLwin Aung[2], Mar Lar Aye[3]


## Abstract

Dye sensitized solar cell converts visible light into electricity using sensitization of the cell. Performances of dye sensitized solar cells are mainly based on dye used as a sensitizer. In my research $TiO_2$ were used as a photo electrode and eosin y, eosin b and methyl red are used as photosensitizers. The structural properties of the synthesized $TiO_2$ particles were studied using XRD and SEM characterization and dyes were observed the absorbance spectra by using UV-Vis absorption spectroscopy. Photovoltaic parameters such as short circuit current, open circuit voltage, fill factor FF, and efficiency were determined under 11 $mW/cm^2$.


**Key words: The three different dyes, DSSC**

## Introduction

The DSSC operation is based on the sensitization of wide bandgap semiconductors such as $TiO_2$ and ZnO. The performance of the cell is mainly dependent on the dye used as sensitizer in addition to many parameters, like the photoelectrode materials, the redox and the back electrode. The absorption spectrum of the dye and its anchorage to the surface of $TiO_2$ or ZnO are the most important parameters determining the efficiency of the DSSC. Generally, transition metal coordination compounds such as ruthenium polypyridyl complexes are used as sensitizers, due to their highly efficient metal-to-ligand charge transfer and intense charge-transfer absorption in the whole visible range. However, ruthenium polypyridyl complexes contain a heavy metal, which is undesirable for environmental aspects.In my research, DSSCs were prepared by using$TiO_2$ electrode and three different dyes (eosin y, eosin b and methyl red). The I-V characteristic, the corresponding output power were determined. The efficiency of each DSSC corresponding to each dye is calculated.

## Preparation of $TiO_2$Paste

Commercially available $TiO_2$powder, was prepared by ball milling to reduce powder size. Milling time is 12 hours. And then mixed with ethanol and sonicate it 72 hours to obtain smaller size. The $TiO_2$ pastes were prepared in two steps. First, the $TiO_2$ was treated with acetylacetone to prevent reaggregation of the $TiO_2$ particles. 2g of $TiO_2$ powder was mixed with 1-mL acetylacetone and the mixture is grounded by agate motor for half an hours. And then the mixture was added with ethylene glycol, acetic acid, acetonitrile and ethanol and the mixture is grounded by agate motor for 5 hours. The solution was heated to evaporate ethanol slowly. Finally $TiO_2$ paste is obtained.

## Preparation of Working Electrode

Fluorine doped Tin oxide on glass (FTO glass, 8Ω /sq, Sigma- Aldrich) was used as asubstrate. FTO conductive glass sheets were cut into pieces of dimensions 2 cm x 2 cm. The samples were cleaned in a detergent solution using an ultrasonic bath for 15 min, rinsed with water and ethanol, and then dried. Thin layers of the prepared $TiO_2$ past were spread on the transparent conducting FTO coated glass by employing doctor blade method. Samples were then dried in an oven at 70 °C for 20 min. Finally, the samples were sintered at 400 °C for 40 min then were cooled down to room temperature.

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## Structural Characterization of $TiO_2$ Film

The phase composition and the crystallite size of the prepared $TiO_2$ samples were evaluated by X-ray diffraction analysis. The peaks of samples after annealing at400°C were identified by comparison with PDF-71-1166 according 2θ which confirmed that an anatase structure at 2θ=25°.

The particle size of nanomaterial is related to the diffraction peak broadening, so X-ray diffraction spectra of synthesized $TiO_2$ nanoparticles were taken and particle size and phase composition were determined. The lattice parameter observed a=b= 3.846, c= 9.578. The nanocrystallineanatase structure was confirmed by sharp peaks obtained corresponding to the planes (101), (103), (004), (200), (105), (211), (213), (204), (116) and (220) indicates the tetragonal structure of $TiO_2$ nanoparticles. All peaks obtained were in good agreement with the PDF card no. 71-1166. The average particle size is calculated by using Debye Scherrer equation.

$$D=K\lambda/\beta\cos\theta$$

Where K known as Scherrer's constant (shape factor), ranging from 0.9 to 1.0, **λ** is the wavelength of the X-ray radiation source which is 1.54056, **β** is the width of the XRD peak at half height and **θ** is Bragg angle. The crystalline sizes of $TiO_2$ is 33.63 nm.Figure(1) show the XRD pattern of $TiO_2$ paste. In XRD pattern there were no impuritiesor reaction product peak observed indicating that the obtained film has pure titania form.

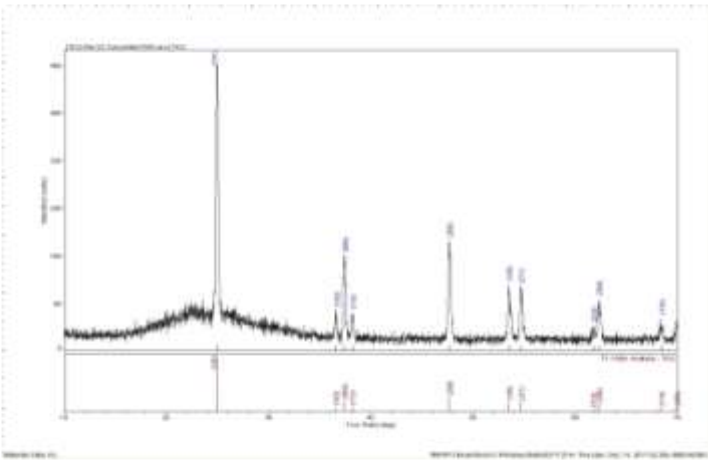


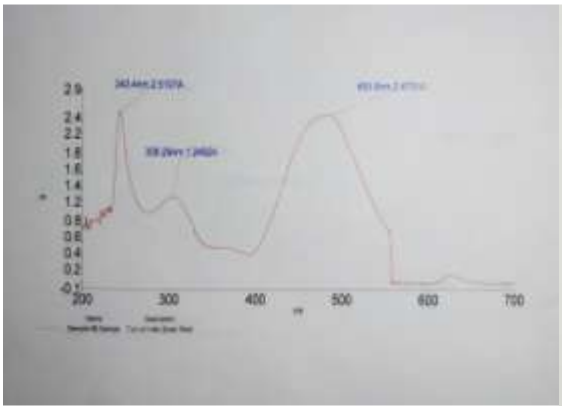
Figure 1: XRD pattern of $TiO_2$ substrate at 400°C

## Preparation of Dye Solution

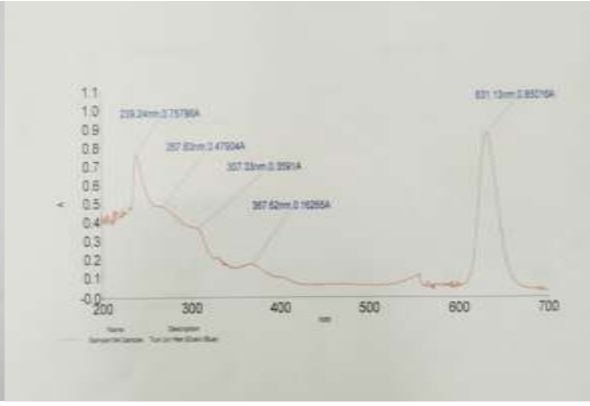
An efficient solar cell sensitizer should absorb strongly to the surface of the semiconductor oxide via anchoring groups, exhibit intense absorption in the visible part of the spectrum, and possess an appropriate energy level alignment of the dye excited state and the conduction band edge of the semiconductor. The performance of DSSCs mainly depends on the molecular structure of the three dyes undergo characterization to observe optical properties by using ultraviolet visible (UV-Vis) Lamda 35 spectrophotometer. The energy band gap value can be obtained from the UV-Vis measurement based on equation.$E = h\upsilon = \frac{hc}{\lambda}$whereh = 6.63 $\times 10^{-34}$Js, c = 3.0 $\times 10^{8}$ m/s and 1eV = 1.60 $\times 10^{-34}$ J.

## UV -Vis Analysis

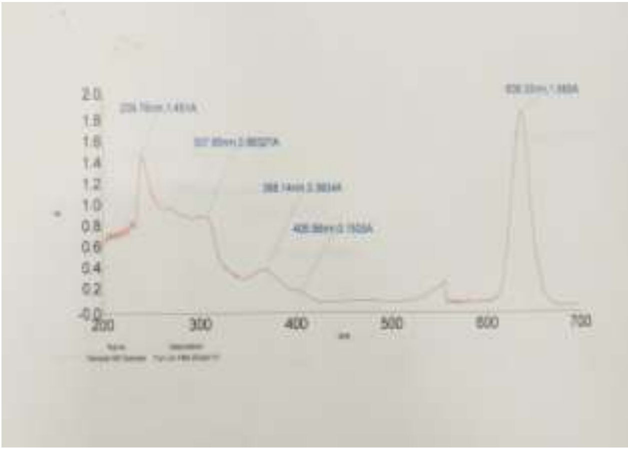
The dyes were characterized by using UV-Vis spectroscopy. UV-Vis spectra provided information about the frequency at which the dyes absorb photons and quantify the absorbed light. The optical absorbance spectrum for methyl red shows a maximum absorption peak in the visible region at 485.6nm wavelength according to the absorbance value 2.4793 as shown in figure 2 (i).



(i)



(ii)



(iii)

Figure 2: Absorbance spectrum of (i) methyl red dye,(ii)eosin blue and (iii)eosin y dye

Upon measuring the absorbance of eosin blue dye, it was found that the dye had a maximum absorption peak in the visible region at 631.13nm wavelength according to the absorbance value 0.85016 as shown in figure 2(ii).The optical absorbance spectrum for eosin y shows a maximum absorption peak in the visible region at 636.33nm wavelength according to the absorbance value 1.885 as shown in figure 2(iii).

**Table 1: Energy Band Gap of Three Different Dyes**

| Dye | Maximum absorption wavelength (nm) | $E = \frac{hc}{\lambda}$ (eV) |
|---|---|---|
| Eosin y | 636.33 | 1.95 |
| Eosin blue | 631.13 | 1.96 |
| Methyl red | 485.60 | 2.56 |

## Preparation of Counter Electrode

Counter electrode in DSSC needs to provide high conductivity as it needs to provide the liquid electrolyte electrons to complete the redox reaction in very short time for lifetime stability and preventing the electron recapture. Commercial graphite powder was mixed with ethanol and placed in ultrasonicator for 72 hours to reduce the powder size by using sonochemical method. Graphite solution was deposited by doctor blade method onto cleaned FTO glass and then heated 400 C for 1hr.

## Preparation of Dye Sensitized Solar Cells

The dyed $TiO_2$ electrode and a sputtered graphide counter electrode were assembled to form a solar cell by sand-wichinga electrolyte solution.

## Results and Discussion

The performance of the natural sensitizers in the photoelectrochemical solar cells was monitored through electrical current and voltage outputs under 11mW/cm$^2$ illuminations. Figures 3,4 and 5show the current-voltage (*I*-*V*) characteristic curves of the assembled DSSCs sensitized withmethyl red,eosin y and eosin b dye extracts. It is clear from these figures that the DSSC sensitized with eosin y extracts exhibit the highest *I*-*V* response. Table 1 presents all the photoelectrochemical parameters of the fabricated DSSCs assembled by photoanodes with $TiO_2$ sensitized by three dyes. These parameters are the short circuit current, $I_{sc}$, open circuit voltage, $V_{oc}$, fill-factor (*FF*), and the cell efficiency ($\eta$). It is shown in Table 2, that the DSSC sensitized with eosin y shows the highest photoelectrochemical performance among the DSSCs.($Isc$=0.11 mA/cm$^2$, $Voc$=0.640 V, $FF$ =0.193, and $\eta$ =0.12).

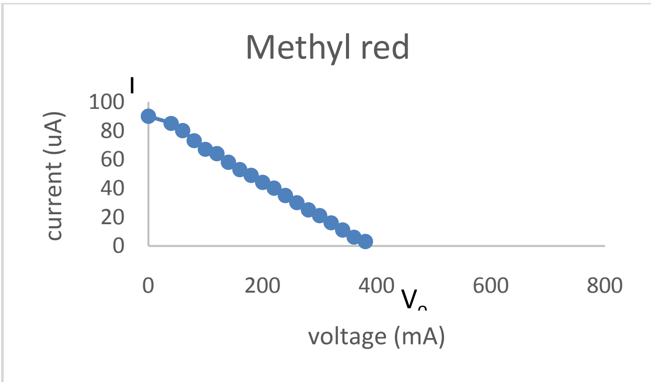
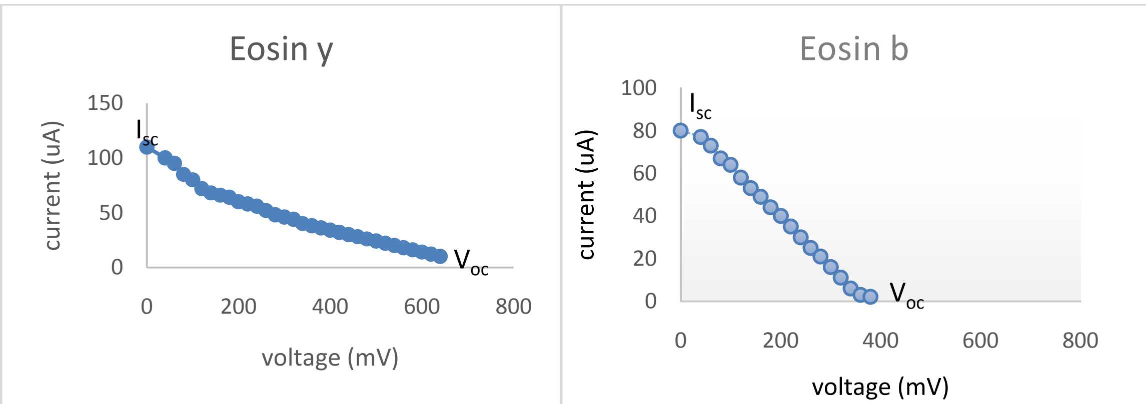



Figure 3: Current and voltage curve for the DSSC sensitized by methyl red




(i) (ii)

Figure 4: Current and voltage curve for the DSSC sensitized by (i) eosin y and (ii)eosin b

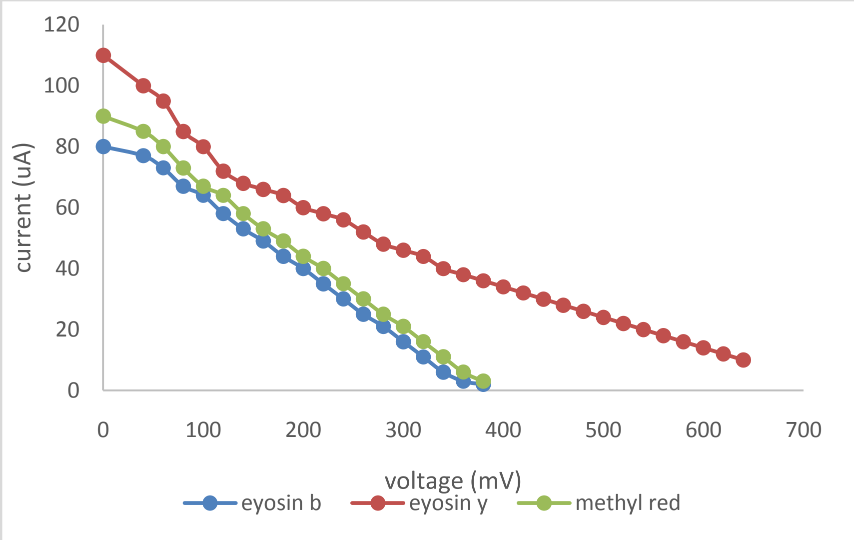



Figure 5:Current and voltage curve for the DSSCs sensitized by three dyes (eosin b, eosin y, methyl red) at intensity of the incident light of 11 mW/cm$^2$

**Table (2) Photovoltaic Parameter of DSSCs using Three Dyes**

| | $I_{sc}$(μA) | $V_{oc}$ (mV) | FF | η |
|---|---|---|---|---|
| Eosin y | 110 | 640 | 0.193 | 0.12 |
| Eosin blue | 80 | 380 | 0.263 | 0.07 |
| Methyl red | 90 | 380 | 0.257 | 0.07 |

## Conclusion

Photovoltaic parameters such as short circuit current, open circuit voltage fill factor FF, and efficiency of DSSCs using three dyes were determined under 11mW/cm$^2$. It was found that the DSSC fabricated with the eosin y dye as a sensitizer show the best performance.

**Acknowledgements**

We wish to express our sincere thanks to Dr Aung Aung Min, Rector-in charge of Pyay University, Dr Thwe Linn Ko,Pro-Rector, Pyay University, for their kind permission to carry out this work.

We also thinks to Professor Dr Soe Soe Nwe, Head of Department of Physics, Pyay University, for her support and encouragement of this research paper.

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# Fabrication and Characterization of Counter Electrode of Graphite Coated Copper Sheet for Dye-Sensitized Solar Cells

Hla Ohn Mar[1], Soe Soe Nwe[2]

## Abstract

The counter electrode of Graphitefor dye-sensitized solar cells (DSSC) has been fabricated by Blade method. It is the new type of counter electrode in DSSC. In this process, Copper (Cu) sheet has been used as the substrate and Graphite as the catalytic material. The characterization of the properties of counter electrode of graphite has been determined by XRD and electrical resistance.

**Key words: dye sensitized solar cells (DSSC), new counter electrode, X-ray diffraction (XRD) and electrical resistance**

## Introduction

It is one of the new types counter electrode for dye-sensitized solar cells (DSSC). It has been fabricated using copper (Cu) sheet as substrate and graphite as the catalytic material which applied by Blade method. The function of the counter electrode is to transfer electrons arriving from the external circuit back to the redox electrolyte. Copper sheet as substrate for graphite has very good electrical conductivity and high temperature resistance. It is a good candidate to fabricate electrode. Both substrate and catalytic material are inexpensive materials, which give a good adhesion between the catalytic material and the substrate. The graphite counter electrode provides a technically and economically credible for p-n junction photovoltaic devices. In this research, the fabrication and characterization of graphite counter electrode are analyzed by using X-ray Diffractometer (XRD) and electrical resistance.

## Materials and Methods

### Sample Preparation

Sample preparation of graphite/Cu electrode includes the following steps. Graphite and $TiO_2$ are used as starting materials. The purity of material is 99.9% of analar grade. Graphite and $TiO_2$ were carefully weighted by digital balance and were mixed in molar ratio of 2:1. This mixture is milled by using agate mortar. And then a little of distilled water were added to yield a homogeneous paste mixture and then milled again. The distilled water was again added still this paste congealed. On the other hand, the copper sheet was cleaned with acetone. This paste was coated on the copper sheet to ensure uniform distribution of this paste throughout the copper sheet. This graphite coated copper sheet was baked in microwave oven at 80ºC for 30 minutes. And then this sample was cooled at room temperature. The graphite counter electrode was prepared by this procedure.

### X-Ray Diffraction Analysis

The graphite powder and graphite coated copper sheet are examined by XRD. X-ray diffraction method, which has been developed rapidly in recent years, is a powerful technique for determination of crystal structure interplannar spacing by using X-ray beam. Thin film

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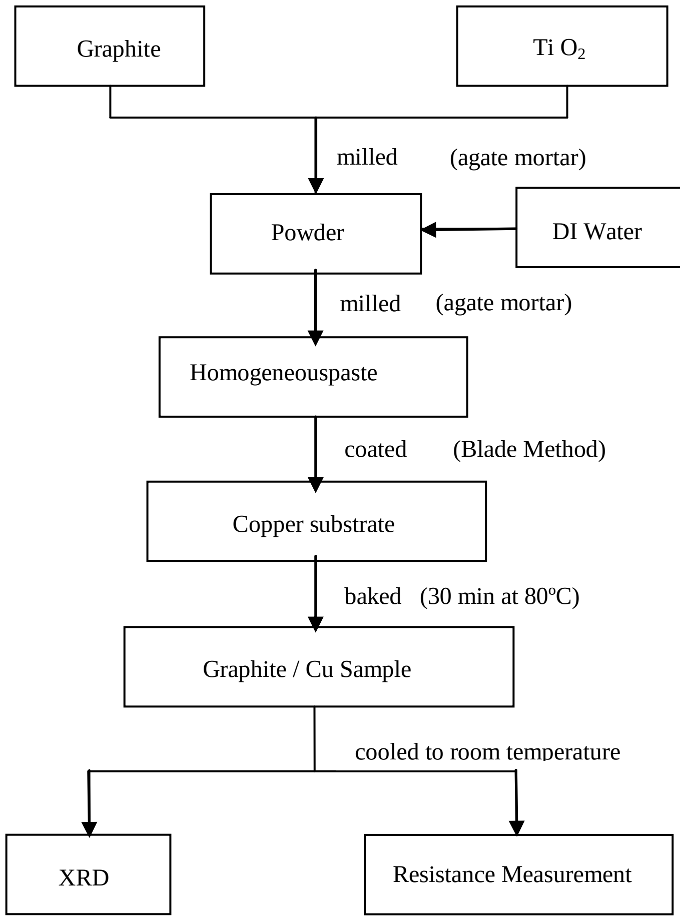


Figure1 The flow diagram preparation of graphite / Cu sample

techniques become a more and more important means to prepare new materials with novel properties.In addition, the technique can be used to obtain information or grain size; a beam of X-ray directed on a crystalline material may experience diffraction (constructive interference) as a result of its interaction with a series of parallel atomic planes according to Bragg's law. For crystal structures having hexagonal symmetry, the Debye-Scherrer's equation can be used as follow.

$$\frac{1}{d_{hkl}^2} = \frac{4}{3}\left(\frac{h^2 + hk^2 + k^2}{a^2}\right) + \frac{l^2}{c^2}$$

**Electrical Resistance Measurement**

In this material field, the basic electrical property is the resistivity ρ. The resistivity ρ of metal or semiconductor is usually given in terms of sheet resistance because it is more convenient. In this work, sheet resistance was measured by using multimeter. One important measurement that can be made with a multimeter is a resistance measure. It may be to measure the resistance of an unknown conductor or it may be to check for short circuits and open circuits. It is possible to determine the resistance with the two probes of multimeter. And then, the resistivity can be calculated by the following equation.

$$\rho = \frac{RA}{L} = \frac{Rwt}{L}$$

where A = Area of cross sectional area
L = Length of the sheet

w = Width of the sheet

t = Thickness of the sheet

## Results and Discussions

The XRD profile for the graphite powder is shown in Figure 2. The most dominant peak (002) was the strongest intensity. The XRD profile for the graphite/copper powder is shown in Figure 3. The most dominant peak (003) was the strongest peak. Some parameter of the XRD analysis of graphite powder and thin film were listed in Table 1 and Table 2. Electrical resistance of counter electrode is an important factor to influence DSSC's efficiency. The high resistance of graphite counter electrode reduces photoelectrical conversion efficiency. The resistance of copper sheet measured with multimeter was 0.2Ω and the resistance of graphite was 1kΩ. The resistance of graphite/Cu sample measured with multimeter was 1.52Ω per one squared centimeter. The resistivity of graphite coated copper sheet deposited by Blade method is $3.28\times10^{-5}\Omega m$.

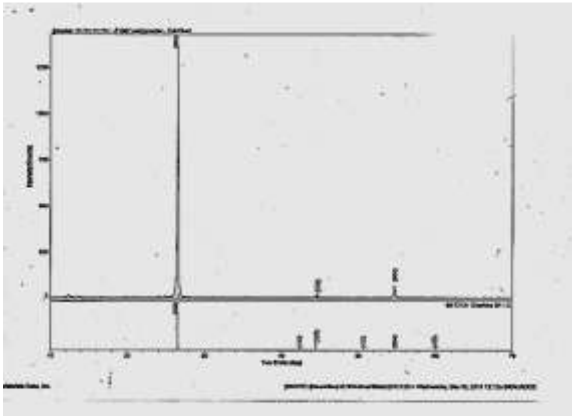

Figure 2 XRD profile for graphite powder

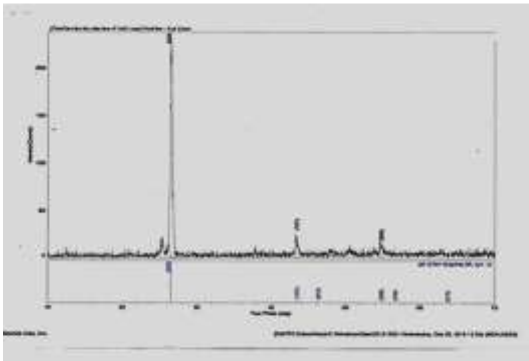

Figure 3 XRD profile for graphite/copper sample

**Table 1 Some Parameters of XRD Analysis of Graphite Powder**

| (hkl) | Bragg angle (degree) | D spacing (Å) | Intensity(%) | FWHM (degree) |
|---|---|---|---|---|
| (002) | 25.585 | 3.3501 | 100 | 0.188 |
| (101) | 44.680 | 2.0265 | 0.6 | 0.172 |
| (004) | 54.683 | 1.6771 | 4.8 | 0.210 |

**Table 2 Some Parameters of XRD Analysis of Graphite/Copper Sample**

| (hkl) | Bragg angle (degree) | D spacing (Å) | Intensity(%) | FWHM (degree) |
|---|---|---|---|---|
| (003) | 26.634 | 3.3441 | 100 | 0.310 |
| (101) | 43.408 | 2.0829 | 8.9 | 0.137 |
| (006) | 54.772 | 1.6746 | 4.9 | 0.416 |

## Conclusion

The counter electrode of graphite/ copper has been successfully fabricated by Blade method. This kind of new counter electrode has the advantages of simple preparation, low cost and good adhesion. According to XRD results, the crystallite size of graphite coated copper sheet was smaller than that of graphite powder. The electrical resistance of graphite and copper sheet are 1kΩ and 0.2Ω respectively. The resistance of graphite coated copper sheet is 1.52 Ω per one squared centimeter.. The decreasing the resistance can control the increasing the photoelectrical conversion factor. The resistivity of graphite coated copper sheet is $3.28\times10^{-5}\Omega$m. It is noted that the lower the resistivity, the higher the conductivity.

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