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Synthesis of Conductive Carbon Sheet From Coconut Fiber with the Addition of Potassium Hydroxide (KOH) Activator

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Abstract. Research has been carried out on manufacturing conductive carbon sheets using carbon as raw material from coconut fiber with a Potassium Hydroxide (KOH) activator. First, activation was carried out using 1000 ml of 6M KOH solution mixed with 100 grams of carbon at 100°C for 72 hours. Next, the carbon is pyrolyzed at temperatures of 900°C, 1100°C, and 1300°C for 2 hours. Next, the pyrolysis carbon was washed with 2M HCl for 24 hours and washed with distilled water until the pH was neutral. Electrical resistance measurements were made with torque variations of 10, 20, and 30 kgf. cm using the four-point probe method, then the conductivity value was calculated. Finally, carbon characterization was carried out using the XRD tool. The increase in pyrolysis temperature causes the carbon conductivity to increase, which is 2.3855- 4.2340 S/cm at 900°C and 6.8203-11.4577 S/cm at 1300°C. XRD analysis showed a sharp and narrow increase in diffraction peaks with each increase in pyrolysis temperature, indicating that carbon has a crystal structure close to graphite which is more ordered than carbon without an activator.

Keywords: Conductive sheet, Carbon, Activator, Electrical conductivity, KOH

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1 Introduction

Cracks Fuel cell is a device that converts chemical energy into electrical energy, including in alternative and renewable energy generation. Currently, many fuel cells are being developed, one of which is proton exchange membrane fuel cells or polymer electrolyte membrane fuel cells (PEMFC). This material has the advantages of relatively high efficiency, high electric current density, low temperature when applied, good fuel supply to the engine, and long-term service time [1-3]. The manufacture of one of the components of the fuel cell, namely the gas diffusion sheet for the electrode is made of carbon. One source of carbon that has been produced from biomass waste is coconut husk.

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Coconut husk is one part of coconut waste which weighs about 35% of the weight of the coconut fruit. This potential waste in the form of coconut husk can be used for industrial/home production activities which have high economic value and are widely used in producing activated carbon.

Activated carbon is a porous material and is commonly used as an adsorbent and in the manufacture of energy device components for various industrial applications. In general, activated carbon can be activated in 2 ways, namely physical and chemical activation. Physical activation is the process of breaking carbon chains from organic compounds contained in carbon with the help of heat at a temperature of 800ºC to 900ºC [4-6]. Chemical activation of activated carbon is carried out by immersing the carbon with chemical compounds before heating [7].

Potassium hydroxide (KOH) is part of a strong base that can be used as a reactant or activator in the manufacture of conductive carbon. KOH as a chemical activator can react well with carbon [8-9].

In this study, carbon processing will be carried out from carbon/coconut fiber charcoal that has been carbonized at a temperature of 500, processing using KOH activator and using a pyrolysis process with temperature variations in the hope that carbon is more conductive and can be used as material for energy devices such as electrode components. Furthermore, sheets using carbon from processing using KOH were also made, then their electrical properties were tested to determine their potential as gas diffusion sheets to be applied to PEMFC electrode components.

2 Methods

Carbonized coconut fiber (SSK) produced by carbonization of 500℃ which passed through a 200 mesh sieve was activated using 6M KOH solution. Activation is done by mixing 100 grams of carbon into 1000 ml of 6M KOH solution. Stir at a temperature of 100℃ for 2 hours and a temperature of 80℃ for 72 hours until the solution forms a paste and then put it in the oven to dry. The pyrolysis process was carried out with temperature variations of 900℃, 1100℃ and 1300℃ with a holding time of 2 hours. The pyrolysis carbon was then washed using 2M HCl solution for 2 hours, then washed with distilled water until the pH of the solution was normal. Then the sediment is taken and dried. Furthermore, the conductivity test and carbon powder characterization were carried out using XRD.

3 Result and Discussion

3.1 Carbon Powder Conductivity

The results of the electrical conductivity test obtained by each sample with a sample pressure were between 2.41721 MPa-7.25163 Mpa of 2.3855 S/cm-11.4578 S/cm. When viewed from the quality of its electrical properties, carbon samples from coco fiber treated using 6 M KOH activator and a pyrolysis temperature of 900 – 1300°C, including strong semiconductor materials, are close to conductor materials [10].

Based on Figure 1, the smallest electrical conductivity value is located at the pyrolysis temperature sample of 900℃, torsion strength of 10 kgf.cm or pressure of 2.41721 Mpa of 2.3855 S/cm, and the largest conductivity is at pyrolysis temperature of 1300℃ with torsional strength of 30 kgf.cm. or 7.25163 Mpa pressure of 11.45786 S/cm.

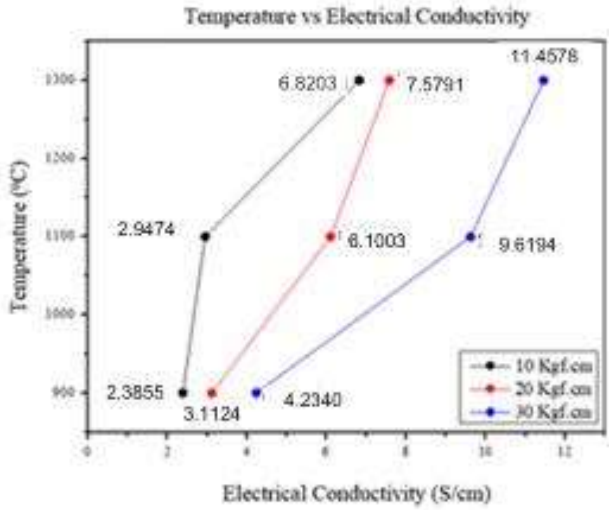

Figure 1. Graph of temperature vs electrical conductivity in each sample

3.2 Carbon Sheet Conductivity

Based on the data processing that has been carried out, the electrical conductivity value of the carbon sheet is obtained as shown in Table 1.

Table 1. Thickness and electrical conductivity of carbon sheet pyrolysis temperature 1300℃

Sample Code	Sample Thickness (L, cm)	Electrical conductivity (S/cm)
C+6M KOH 1300_A-0	0.106	0.0118
C+6M KOH 1300_B-1	0.111	0.0134
C+6M KOH 1300_B-2	0.106	0.0114
C+6M KOH 1300_B-3	0.114	0.0133
σ Average (S/cm)		**0.0125**

The electrical conductivity value of the carbon sheet obtained is 0.0125 S/cm. This value is smaller than the electrical conductivity value obtained in carbon powder, this is because to make carbon sheets, carbon powder is mixed with polymer. The quality of the carbon composite sheet is still a semiconductor material group, the electrical conductivity value is around the order of 10^{-2} S/cm. This value is quite capable of conducting electric current, it needs further development because it has the potential for application as a PEMFC electrode GDL.

3.3 *X-Ray Difraction* (XRD) Test

Figure 2 shows the diffraction pattern produced in carbon samples activating using 6M KOH, indicating a significant peak in the XRD results, when compared to the XRD results of carbon without the addition of activator. This proves that the addition of an activator and an increase in the pyrolysis temperature on charcoal/carbon can increase the peak intensity and change the crystal structure closer to graphite. The peak intensity increases, this is due to KOH at increasing temperatures in addition to adding, opening and expanding carbon pores. The effect of KOH treatment also makes the carbon structure more neat/organized closer to the graphite phase structure.

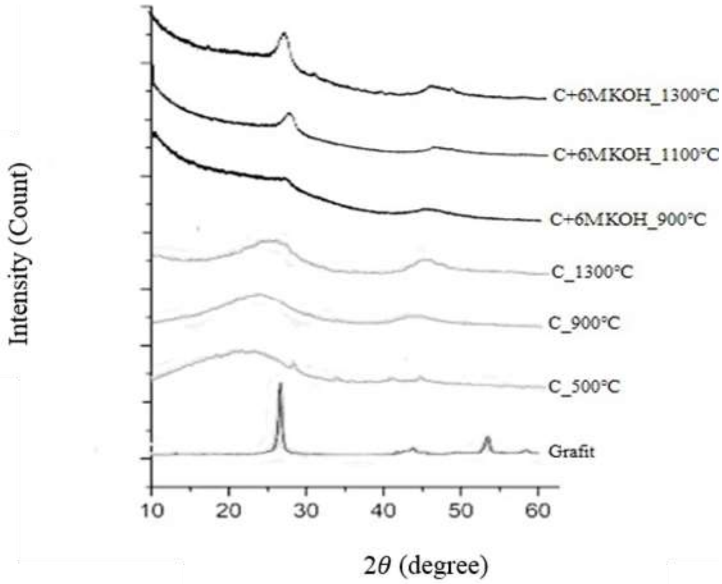

Figure 2. XRD results of combined carbon samples without activator and carbon samples using KOH activator

The test results for the C+6M KOH sample in Table 2 obtained the lowest intensity peak (1971.00) from the sample with the code C+6M KOH_900℃ at 2-theta angle of 24.87º, the highest intensity peak (2664.00) from the sample with code C+6M KOH_1300℃ at 2-theta angle of 25.94° and has conductivity values including semiconductor materials in positions near metallic materials. The XRD results were quite successful in making carbon with a crystal structure close to the graphite phase structure, where the angle position of 2-theta graphite is 26.04°, and its conductivity is in the metallic region which is a conductor material and is suitable for use as a PEMFC component.

Table 2. The degree of crystallinity of carbon samples with the addition of KOH activator

Sample Code	2θ (Degree)	Peak Crystallinity
C+6M KOH_900°C	24.87	1971.00
C+6M KOH_1100°C	25.92	2507.00
C+6M KOH_1300°C	25.94	2664.00

4 Conclucion

The results of the electrical conductivity of carbon are between 2.3855 S/cm to 11.4578 S/cm. This condition is classified as a strong semiconductor material. While the carbon sheet has an electrical conductivity value of about 0.0125 S/cm, the result is classified as a semiconductor material. The results of testing the electrical properties of carbon have the potential for application as an electrode material. The addition of KOH and variations in the pyrolysis temperature have an effect on the carbon structure and increase the electrical conductivity value.

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