EFFECT OF FERUM LOADING ON THE PROPERTIES OF GRAPHITE/CARBON BLACK/POLYPROPYLENE COMPOSITE AS BIPOLAR PLATE

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This report is submitted
in fulfillment of the requirement for the degree of
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DECLARATION

I declare that this project report entitled “Effect Of Ferum Loading On The Properties Of Graphite/Carbon Black/Polypropylene Composite As Bipolar Plate” is the result of my own work except as cited in the references

Signature	:	....
Name	:	....
Date	:	....

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Structure & Materials).

Signature :. ....

Name of Supervisor : ....

Date : ....

DEDICATION

To my beloved parents

Mr.S.BASKARAN

Mrs.S.SELVI

My Supervisor,

DR. MOHD ZULKEFLI BIN SELAMAT

Other

Labratorory technician especially to Mr. Rizal, my friends and all people that had guided me throughout completion of this project.

ABSTRACT

Past few years, they are many processes has been conducting in understanding and improvement of Polymer Electrolyte Membrane Fuel Cell (PEMFC) The performance of PEMFC is relies upon the bipolar plates. This research is about the improvement of bipolar plate through multi-filler application by Ferum were fabricated through a selection of process. They are pre-mixing of raw materials, ball milling, pulverizing and compression molding. For electric conductivity the adding of 10wt% of Ferum plate demonstrates higher conductivity contrasted with other composition. Ferum 10 wt.% plate shows higher flexural strength when compared with others composition. With respect to density and shore hardness, 10wt% Ferum demonstrates unrivaled estimation of 1.489 g/cm³ and 70.8 individually. Therefore, the properties of adding 10 wt.% of Ferum to bipolar plate only composition exceed all target set by US-Department Of Energy.

ABSTRAK

Beberapa tahun yang lalu, mereka banyak proses yang sedang dijalankan dalam pemahaman dan peningkatan sel bahan bakar elektrolit elektrolit polimer (PEMFC) prestasi PEMFC bergantung kepada plat bipolar. Kajian ini adalah tentang peningkatan plat bipolar melalui aplikasi multi-filler oleh Ferum yang dibuat melalui proses pemilihan. Mereka adalah pra pencampuran bahan mentah, pengkompaunan, pemolesan dan pengacuan mampatan. Untuk kekonduksian elektrik penambahan 10wt% plat Ferum menunjukkan kekonduksian yang lebih tinggi berbanding dengan komposisi lain. Plat 10 gram ferum menunjukkan kekuatan lentur yang lebih tinggi apabila dibandingkan dengan komposisi yang lain. Berkenaan dengan ketumpatan dan kekerasan pantai, 10wt% Ferum menunjukkan taksiran yang tiada tandingannya 1.489 g / cm^3 dan 70.8 secara individu. Oleh itu, sifat-sifat menambah 10% berat Ferum untuk plat bipolar hanya melebihi semua sasaran yang ditetapkan oleh US-DOE.

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PEMFC	Proton exchange membrane fuel cells
PEM	Proton exchange membrane
BPs	Bipolar Plates
GDL	Gas diffusion layer
CO	Carbon Monoxide
Pt-Ru	Platinum-Ruthenium
Fe	Ferum
CB	Carbon Black
Gr	Graphite
PP	Polypropylene
US-DOE	Unites States Department of Energy

CHAPTER 1

INTRODUCTION

1.1 Overview

The polymer electron membrane fuel cell (PEMFC) is current trending topic among researchers which is an electrochemical device that converts chemical energy into electrical energy. PEMFC is also not necessary for combustion process due to that it's considered to distributed portable electronics, power transportation and generation. Since that, PEMFC expected to play a major function in the world economy by decrease ecological issues. Bipolar plate (BP) is one of the fundamental parts of PEMFC, which takes haft portion of the total weight, cost and volume of the stack. The function of stack is to carry electric current away from each cell, it distributes anode with hydrogen and cathode with oxygen within individual cell and provides electron flow between the poles. In order to perform well the proper materials selecting is importance for devices has become serious research issues. Hence a materials selecting is most challenging things due to achieve the criteria of materials which established by United States Department of Energy (DOE) as shown in Table 1 [1].

Table 1: Requirement properties for the bipolar plate [2]

Property	Value
Electrical conductivity	>100 S/cm
Shore hardness	>50
Flexural strength	>25MPa
Bulk density	<5 [g/cm³]

Pure graphite is one of the more conventional materials utilized to create bipolar plate because of their advantage of excellent chemical compatibility and great erosion safe. However, a few issues with pure graphite are during fabrication process is too expensive and time consuming, especially the machining procedure of gas stream channel into the plate surface and brittleness would cause the fuel stack to be overwhelming and huge.

For metal filler such as iron (Fe), stainless steel (SS), aluminum nickel, and titanium are commonly used Metal plates offer higher strength, toughness and shock resistance than graphite plates, and their unique mechanical properties allow for fabrication of thinner plates. However, there are also having some disadvantage by using metal filler such as high surface resistances and their helplessness to erosion.

Beside the type of fillers, thermoplastic or thermoset matrices could use to manufacture bipolar plates composites. There are a few models of thermoplastics lattices utilizing, for example, polypropylene (PP), polyphenylene sulfide (PPS), and polyvinylidene fluoride (PVDF). Polypropylene is promising materials lattice in regard to great mechanical properties and the expense however its primary chain does not contain polar gathering; in this way legitimate attachment can't be guarantee between the filler and framework.

Conducting polymer composite (CPC) as bipolar plates an appealing option in contrast to pure graphite and metal bipolar plates. Moreover, CPC is having capacity to give the important properties, for example, good mechanical strength, electrical and thermal conductivity. In other word, it necessary to do profound research on the blend of multi fillers bipolar plate materials to acquire the better properties of the composite. Therefore, graphite (G), carbon black (CB), carbon nanotubes (CNT) and carbon fillers (CF) are the a few materials utilized broadly in CPCs [2]. Furthermore, the thickness of the composite is exceedingly critical parameter in PEMFC considers. The mechanical quality relies upon the thickness of the composite. Low thickness in a composite advances a reduction in resistance and an expansion in the conductance of proton exchange membrane, which thus causes an increment in fuel cell execution.

The aim of the present work is to investigate the effect of Ferum (Fe) loading in multi filler Gr/CB/Fe/PP composite for bipolar plate PEMFC with the end goal to accomplish the necessity of the US DOE targets. The paper likewise investigates electrical conductivity and flexural quality properties of Gr/CB/Fe/PP composite were examined.

1.2 Problem statement

In this research, graphite is to be utilized as primary filler in view of high corrosion resistance, yet it is confronting primary debilitations which are weak and low conductivity. Additionally, the metal filler is ferum, which high conductivity however propensity to corrosive, and need to do good coating where it's exceptionally costly. Moreover, polypropylene is intense and adaptable, it's reasonable for cover to give awesome quality. Since, CPC is good corrosion resistance, lightweight, low cost and ease of machining or molding gas channels during processing. The main concept of utilizing multi filler, for example, Gr, CB and Fe is to decide the critical ratio of Fe which gives the best electrical conductivity and mechanical properties for G/CB/Fe/PP composite.

1.3 Objectives

- To study the effect of Ferum (Fe) loading on the electrical and mechanical properties of G/CB/Fe/PP composite.
- To determine the critical loading of Fe in G/CB/Fe/PP composite.

1.4 Scope

In this research, the study will cover the effect of Fe loading on the electrical and mechanical properties of G/CB/PP composite. The ratio of fillers (G/CB/Fe) and binder (PP) is fixed at 80:20. The adding small amount of Fe into G/CB/PP composite thus will give synergy effects on electrical conductivity and mechanical properties. The small amount of Fe which is 0 wt.% up to 15wt.% which is from the total weight of fillers 80% will be added into G/CB/Fe/PP composite and the CB has been fixed 25 wt%. All the fillers of G/CB/Fe will blend utilizing a ball mill process machine for one to accomplish homogenous blends. From that point forward, the G/CB/Fe will mix with PP through ball mill machine. After the intensifying procedure finished, the blends will gather and pummeled to additionally refine the examples as some of them agglomerate and frame bumps. This procedure will finish utilizing Retsch ZM200 Pulverizer. The following stage, the compression molding technique will mold the bipolar plate sample which will use Gotech (GT7014-A) hot press machine. Before the compression process begins, the temperature should be set to 180°C. From that point forward, the form will put in the hot press machine. The preheating procedure time takes around 10 minutes subsequent to a heating procedure is finish. At that point, the shape will expel from hot press space and place in cool press space. After 15 minutes the specimen will be expelled from the form. In order to determine the effect of loading Fe in G/CB/Fe/PP composite, the tests such as electrical conductivity, flexure test, density test, and hardness test will be performed. For determine the electrical conductivity properties, Jandel Multiheight Microposition Probe ware using for the test the plate. Lastly, the plate will be tried by utilizing Electronic Densimeter and Digital Tester to decide its density and hardness separately.

CHAPTER 2

LITERATURE REVIEW

2.1 Fuel cell

Fuel cell is a device that convert the chemical energy of a fuel straight forwardly into electricity by electrochemical process[3].Fuel cells work like batteries, yet they don't once-over or require recharging. They create power and heat insofar as fuel is provided. Thus, fuel cells have been utilized for a considerable length of time in transportation, material handling, stationary, convenient, and crisis reinforcement control applications.

Other than that, fuel cells have a few advantages over customary combustion-based innovations at present utilized in many power plants and traveler vehicles. Fuel cells can work at higher efficiencies than combustion engines and can change over the chemical energy in the fuel to electrical energy with efficiencies of up to 60%. Fuel cells have brought down outflows than combustion engines. Hydrogen fuel cells produce just water, so there are no carbon dioxide outflows and no air contaminations that make exhaust cloud and cause medical issues at the purpose of task.

A fuel cell comprises of two electrodes which is a negative electrode (anode) and a positive electrode (cathode). The anode which supplies electrons where the cathode retains electrons. The two electrodes must be immersed and isolated by an electrolyte which might be a fluid or solid, but which should in either case conduct ions between the electrodes with the end goal to finish the chemistry of the system. A fuel, for example, hydrogen is sustained to the anode and air is encouraged to the cathode. In a hydrogen fuel cell, a catalyst at the anode isolates hydrogen particles into protons and electrons, which take different ways to the cathode. The electrons experience an outer circuit, making a stream of electricity. The protons relocate through the electrolyte to the cathode, where they join with oxygen and the electrons to deliver water and heat. Figure 2.1 shows the fuel cell.

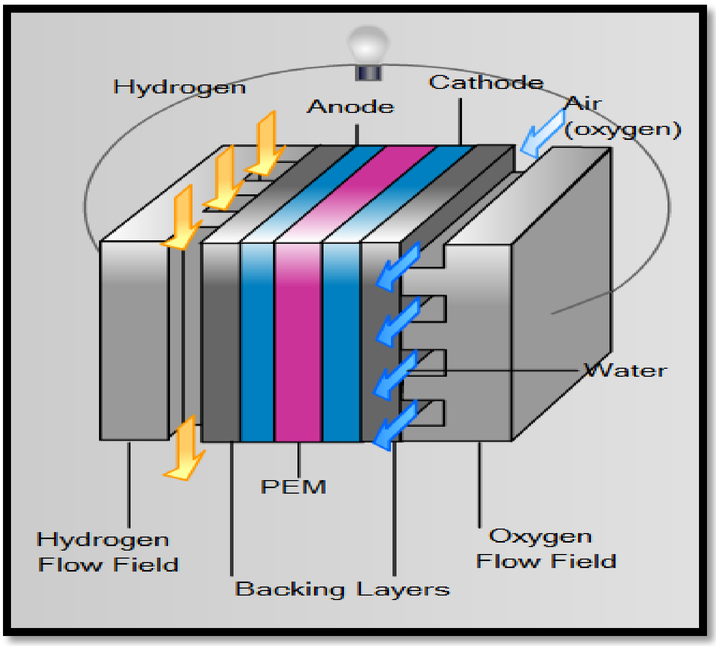

Figure 2.1: Fuel Cell [4]

2.2 Type of fuel cells

There are a few types of fuel cells right now a work in progress, each with its own advantages, constraints, and potential applications. The fuel cells classified by type of electrolyte they used. Polymer Electrolyte Membrane (PEM) Fuel Cells, Direct Methanol Fuel Cells (DMFCs), Alkaline Fuel Cells (AFCs), Phosphoric Acid Fuel Cells (PAFCs), Molten Carbonate Fuel Cells (MCFCs), and Solid Oxide Fuel Cells (SOFCs).

2.2.1 Direct methanol fuel cell

The direct methanol fuel cells (DMFCs) as shows in Figure 2.2 has been considered as the perfect fuel cell system since it produces electric power by the direct change of the methanol fuel at the fuel cell anode. Besides that, methanol offers a few points of interest as a fuel. It is reasonable however has a generally high energy density and can be effectively transported and saved. It tends to be provided to the fuel cell unit from a liquid repository which can be kept beaten up, or in cartridges which can be immediately changed out when spent. DMFCs is also will in general be utilized in applications with moderate power necessities such as in mobile electric gadgets and chargers[5]. Moreover, DMFCs work in the high pressure and temperature range from 60ºC to 130ºC which causes many losses in the system. The methanol traverses the membrane and sustained as a weak solution as it diffuses over the membrane without reacting. This condition lessen effectiveness to vast degree since the traversed methanol responds with air at cathode lastly causing decrease in cell voltage as the result.

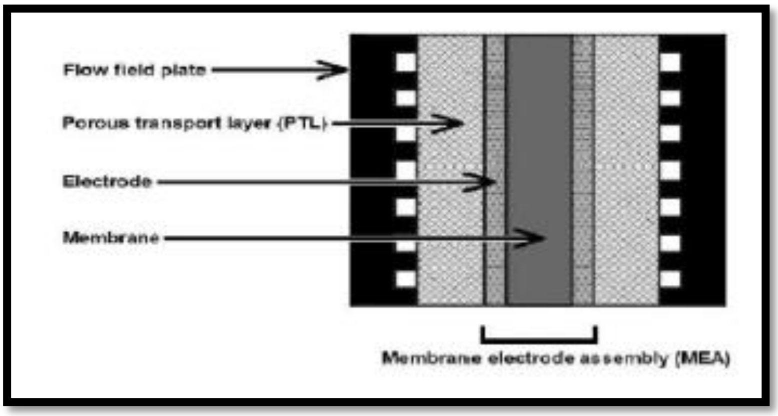

Figure 2.2: Direct Methanol Fuel Cell [5]

2.2.2 Alkaline fuel cell

Alkaline Fuel Cells (AFCs) uses watery solution of potassium hydroxide as the electrolyte. The fuel is work on compacted hydrogen and oxygen. The primary AFCs worked at somewhere in the range of 100ºC and 250ºC, yet common working temperatures are presently around 70ºC. Furthermore, AFCs were one of the primary energy component advances to be created and were initially utilized by NASA in the space program to deliver both power and water. Other than that, these types of fuel cell are easily harmed by carbon dioxide. Even the little measure of carbon dioxide in the air can affect this fuel cell task so that making it important to clean both the hydrogen and oxygen use in the cell. This refinement procedure is expensive to fuel cells. Since it is helplessness to harming additionally influences the cell's lifetime to further adding to cost. Figure 2.3 shows the alkaline fuel cell.