home

5th INTERNATIONAL CONFERENCE on VOCATIONAL EDUCATION of MECHANICAL and AUTOMOTIVE TECHNOLOGY (ICoVEMAT) 2022

Yogyakarta, October 6, 2022

Universitas Negeri Yogyakarta

Theme :

Green Technology on Automotive and Manufacture for Sustainability Life

Speakers :

Taiwan

Prof. Dr. Ing. Oliver Michler
Institut für Verkehrstelematik, Technische Universität Dresden, Germany

Prof. Dr. Ing. Lee Seonha
Department of Construction and Environmental Engineering, Kongju National University, Republic of Korea

Associate Professor Ferry Jie, Ph.D, FCILT., FCES.
Edith Cowan University, Australia

Dr. Eng. Ir. Didik Nurhadiyanto, M.T., IPU
Department of Mechanical Engineering Education, Faculty of Engineering, Universitas Negeri Yogyakarta, Indonesia

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List Of :

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PARTICIPANTS

PREVIOUS EVENT:

Proceeding 3rd ICoVEMAT 2020 (Indexed by Scopus)

Proceeding 2nd ICoVEMAT 2019 (Indexed by Scopus)

Proceeding 1st ICoVEMAT 2018 (Indexed by Scopus)

Background

Research in manufacturing covers many aspects, including: additive manufacturing, automation and robotics, advanced materials, sensors and data analysis, augmented and virtual reality. Based on the results of research in this field, the manufacturing process of a product will be more effective and efficient. The automotive manufacturing industry is now able to make products faster because of this research. A car factory in Indonesia is supported by modern equipment and high technology in every stage of its process, with 40 percent of the total production process using robots. These processes include: Stamping, Welding, Painting, and Assembling. Innovation has many definitions. New products, process and business models that deliver commercial value and catalyse growth opportunities. Manufacturing innovation promise to impact every aspect of the manufacturing businesses, from design, research and development, production, supply chain and logistics management through to sales, marketing and even end of life management. These innovations will create highly intelligent, information-driven factories and distributed business models that can respond rapidly to change and deliver entirely new customised smart products and services (https://www.imcrc.org/manufacturing-innovation/).

Therefore, the Mechanical and Automotive Engineering Education Department, Universitas Negeri Yogyakarta organize the 5th International Conference on Vocational Education of Mechanical and Automotive Technology (ICoVEMAT) 2022. The aim of the 5th ICOVEMAT 2022 is to provide a platform for educators, academicians, researchers, and industry professionals from all over the world to share their idea, research results, and discuss the research and innovation in mechanical and automotive technology. It also provides an opportunity for participants to find global partners for future collaboration. We invite you to join us on 6th, October 2022 in Yogyakarta, Indonesia.

TIME SCHEDULE

Time (WIB)	Agenda
07.00 - 08.00	Registration
	all participants joint in zoom meeting https://uny.id/ictvt2022
	https://uny.id/ictvt2022 Meeting ID: 927 9625 4182 Passcode: ICTVT2022
08.00 - 08.05	Opening and Nation Anthem "Indonesia Raya"
08.05 - 08.10	Welcome Speech Chairman Organizer of by Dean of Faculty of Engineering
08.10 - 08.20	Welcome and Opening Speech by Rector of Universitas Negeri Yogyakarta
08.20 - 08.40	**Keynote Speaker** Prof. Dr. Muhadjir Effendy, M.A.P. (Coordinating Minister for Human Development and Culture of Indonesia)
08.40 - 09.20	**Plenary Session I** Moderator: Yuyun Yulia, M.Pd., Ph.D. (Vice Rector of Cooperation and Public Relation Affairs, Universitas Sarjanawiyata Tamansiswa, Indonesia)
	Speaker 1 : Prof. Jenq-Shiou Leu, Ph.D. (Department of Electronic and Computer Engineering, National Taiwan University of Science and Technology, Taiwan) Speaker 2 : Prof. Dr. Eng. Ir. Didik Nurhadiyanto, M.T., IPU (Department of Mechanical Engineering Education, Universitas Negeri Yogyakarta, Indonesia)
09.20 - 10.00	Discussion
10.00 - 11.00	**Plenary Session II** Moderator : Dr. Phil. Ir. Didik Hariyanto, S.Pd.T., M.T. (Universitas Negeri Yogyakarta, Indonesia)
	Speaker 3 : Assoc. Prof. Ferry Jie, PhD, FCILT, FCES (Edith Cowan University, Australia) Speaker 4 : Prof. Dr. Ing. Lee Seonha (Department of Construction and Environmental Engineering, Kongju National University, Republic of Korea) Speaker 5 : Prof. Dr. Ing. Oliver Michler (Institut für Verkehrstelematik, Technische Universität Dresden, Germany)
11.00 - 12.00	Discussion
12.00 - 13.00	Lunch Break
13.00 - 16.30	**Parallel Session** https://bit.ly/icovemat2022 Meeting ID: 937 5372 3586 Passcode: icovemat

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	Mohd Azri Hizami Bin Rasid	Universiti Malaysia Pahang	
	Sutiman	Universitas Negeri Yogyakarta	
2	Herminarto Sofyan	Universitas Negeri Yogyakarta	The Effect of Resin Ratio and Hardener Matrix Epoxy on the Carbon Fiber Composite Tensile Force
	Sukaswanto	Universitas Negeri Yogyakarta	
	Resa Agus Setyawan	Universitas Negeri Yogyakarta	
	Muhammad Nurdin Wahid	Universitas Negeri Yogyakarta	
3	I Wayan Warsita	Universitas Negeri Yogyakarta	Current Working Point Effect on BLDC Motor Temperature and Efficiency
	I Wayan Adiyasa	Universitas Negeri Yogyakarta	
	Mohd Azri Hizami Razid	Universiti Malaysia Pahang	
4	Ms. Ayu Sandra Dewi	Universitas Negeri Yogyakarta	BLDC Motor Performance Modeling for Electric Vehicles Based on Battery Performance
	Mr. I Wayan Adiyasa	Universitas Negeri Yogyakarta	
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5	I Wayan Adiyasa	Universitas Negeri Yogyakarta	Analysis of Solar and Wind Energy Potential on the Design of a 16 kWh Swab Battery Charging System
	Yogi Arta	Politeknik Transportasi Darat Bali	
	Rai Pramesti	Universitas Brawijaya	
6	Syaian Nur Fajri	National Yunlin University of Science and Technology	Development of Pole-Piece Shapes in Coaxial Magnetic Gears
	Ibnu Siswanto	Universitas Negeri Yogyakarta	
7	Agung Prasetyo	Universitas Negeri Yogyakarta	Electrical System of Prototype Electric Vehicle for Disable
	Ibnu Siswanto	Universitas Negeri Yogyakarta	
	Abdulah Syafiq	National Central University	
	Fajar Ardian Ikhwansyah	Universitas Negeri Yogyakarta	
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3	Muhkamad Wakid	Universitas Negeri Yogyakarta	The Effect of Toe Adjustment on the Garuda Urban Gasoline 2020 (UG 20) Vehicle Glide Distance
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4	Yoga Guntur Sampurno	Universitas Negeri Yogyakarta	The Effect of Variations Ignition Timing on Characteristics And Exhaust Emission on Yamaha Vega Force FI Engines Using
	Ardiyan Rifki Stevanni	Universitas Negeri Yogyakarta	
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5	Sudarwanto	Universitas Negeri Yogyakarta	Injection Duration Mapping Effect on K0J Engine Power and Fuel Consumption
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7	Khusni Syauqi	Universitas Negeri Yogyakarta	Pulley Design as Powertrain Mechanism in a Wheelchair Portable Electric Motor
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6	Gunadi	Universitas Negeri Yogyakarta	The Effect Carbon Fiber Composite with Core Variations on Flexural Strength and Density on The Reinforcement of The Urban Vehicle Garuda UNY
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7	I Kadek Warjaya	Universitas Negeri Yogyakarta	Performance Analysis of Throttle by Wire using DC and BLDC Motor Actuator
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	Khalid Himawan	Universitas Negeri Yogyakarta	

Graphite Coating of Aluminum Bipolar Plate Using Compression Molding Method

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Abstract. Bipolar plate is one of the most important and quite expensive parts of Proton Exchange Membrane Fuel Cell (PEMFC). This research was conducted to compare the value of electrical electrical conductivity, microstructure and flexural strength of the bipolar plate that acts as conductor based on the composition of the bipolar plate. The mass composition of the graphite and epoxy resin are at 60:40, 70-30 and 80-20 was used in compression molding process at 6 tons in 30 minutes. Electrical conductivity tests, microstructural observations and bending tests were carried out. It was found that the high electrical electrical conductivity value at 50 $S.cm^{-1}$ and best microstructure surface in 80:20 specimen. As for the bending test, the highest value at 101.9MPa is found on 60:40 specimen. The results show that higher composition of graphite will elevate the electrical conductivity and higher composition of epoxy resin will elevate the bending test value of the aluminum bipolar plate.

INTRODUCTION

In a PEMFC system, bipolar plate has a critical role as the medium for water and hydrogen. These two are the source of the energy in fuel cell. PEMFC operates at low temperature and due to this, it requires pure hydrogen as the energy source [1]. With its low operating temperature and zero emissions, PEMFC became one of the most effective and popular source of energy [2-4]. Due to the low operating temperature, PEMFC also commonly refer to as low-temperature PEMFC (LT-PEMFC). Hence why the bipolar plate must have a good ability for conducting the electric.

Metals, due to its good electrical conductivity suited as the material for the bipolar plate. Metallic plate will produce better conductivity but at the same time it poses problems such as corrosion. Metallic material such as aluminum produce impressive electical and thermal conductivity with also good mechanical properties [5]. From the economical point of view, it is not desirable to use metals for mass production. Even though the use of noble metal is a possibility, but again it is not feasible due to the cost. As an alternative, metallic polymer plate is developed to handle the corrosion problem while at the same time maintaining a good electrical conductivity.

Graphite is a well known material in the bipolar plate advancement. It exhibits good electrical and thermal conductivity [6], suitable to handle the corrosion problem at the cost of still lower conductivity compared to metals. Developing composite plate by adding graphite with metals were done in recent research and obtained better electrical conductivity and peak power output [7]. Several research utilizing Ti as a coating and found better corrosion resistance and electrical conductivity [8-9]. Graphite coating is utilized by methods such as injection molding, compression molding and etc depends on the materials used.

Compression molding is more fitting as manufacturing method of bipolar plate compared to machining process because the production cost is more expensive for machining. Machining process is gradually eliminated due to this reason [10], even though it is possible to applied machining process for the fabrication of the flow channel of a bipolar plate. For graphite coating aluminum process it is easier for the fabrication using compression method. This method is also popularly used for researching the effect of the varied composition of materials used for bipolar plate. The composition of the graphite into the aluminum will be researched. The composition ration will be between the graphite and epoxy resin that acts as the binder or adhesive.

METHOD

Materials and Equipments

These were the equipments used for supporting this research :

a) Aluminum plate AA1100
b) Specimen molding with the dimension of 12cmx12cmx1cm
c) Amorphous Graphite produced by Evergreen Industries as the coating of the plate
d) Epoxy resin as an adhesive

e) Aquades water to remove dirt from the specimen
f) Conductivity tester
g) Olympus BX53M Microscope
h) Bending machine

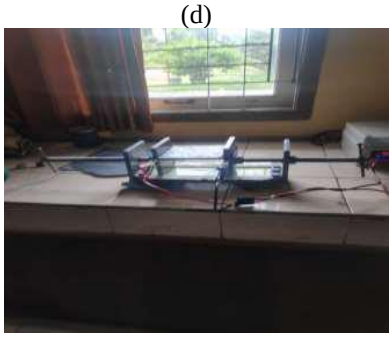

(a)


(b)


(c)

(d)


(e)


(f)


(g)


(h)

Figure 1. Materials and equipments in the research

Procedure

This research used aluminum plate that coated by graphite and epoxy resin as the specimen. Aluminum plate was put in the molding then coated and subjected to compression for coating process in a mold with dimension of 12cmx12cmx1cm. The compression molding were done with 6 ton force during 30 minutes. There were 3 types of composition between graphite and epoxy resin, namely were 60:40, 70:30 and 80:20 ratio based on the mass. The mass was calculated based on the volume of the mold and density of both graphite and epoxy resin.

When the specimens were collected from the mold, the specimens cleaned by aquade to remove any possible dirts. Some tests were carried out to determine the effect of the variation on the composition. The tests were electrical conductivity measured by condutivity tester using ASTM B193 standard, microstructure obeservation using Olympus microscope and bending test by bending machine. The tests are done in Laboratory of Department of Mechanical Engineering Universitas Islam Riau. All materials and equipment for the research are shown by figure 1a to 1h.

RESULTS AND DISCUSSIONS

Here are the results of the test on the specimens. There were 3 tests done, they were electrical conductivity, microstructure and bending test.

Electrical Conductivity Test

Table 1. Electrical conductivity of specimens

No	Composition (%)	Conductance (S)	Electrical Conductivity (S.cm-1)
1	60 : 40	142	14.2
2	70 : 30	250	25
3	80 : 20	500	50

Table 1 shows the average value of electrical conductivity of the 3 types of bipolar plate measured by the conductivity tester. The lowest value of electrical conductivity is at composition of 60:40 with 14.2Scm-^{1} and the highest is at composition 80:20 with value of 50Scm-^{1}. It is clear that the higher composition of graphite will increase the electrical conductivity of a plate. This could be resulted due to the nature of graphite that had good conductivity. Figure 3 below shows the trend of the electrical conductivity on different composition. There is a quite significant increase in conductivity between composition 70:30 to 80:20 compared with 60:40 to 70:30.

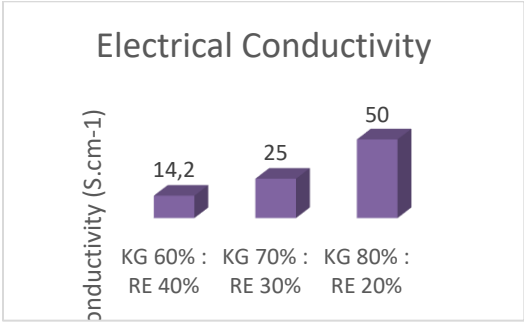


Figure 2. Electrical conductivity

Microstructure Observation

Microstrucre observation on the 3 types of specimens are done. From figure 3, it is shown that there is uneven distribution of graphite of the specimen 60:40. This is due to the dominant use epoxy resin up to 40 percent and cause the spread of the graphite became not well distributed. This microstructure of specimen with 60:40 composition shows that the surface looks rough dan porous. All of these are cause by the amount of epoxy resin use in the specimen is dominant even though it only used at 40 percent of total.

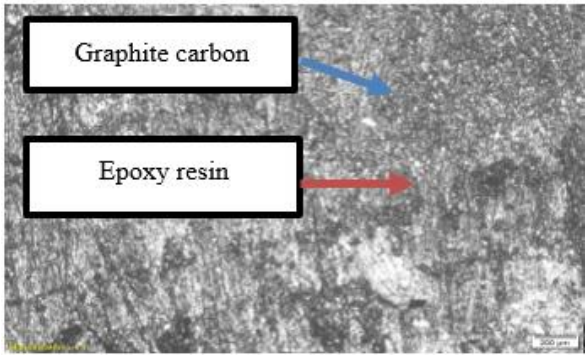


Figure 3. Microstructure of 60% graphite and 40% epoxy resin

The microstructure of 70:30 specimen is shown by figure 4. From the observation, it could be known that the particles of the graphite and epoxy resin are well and evenly distributed. This occur due to the larger amount of graphite used making the surface appears to be smoother. The result of 70:30 microstructure is different compared to the 60:40 with former being less porous than the latter.

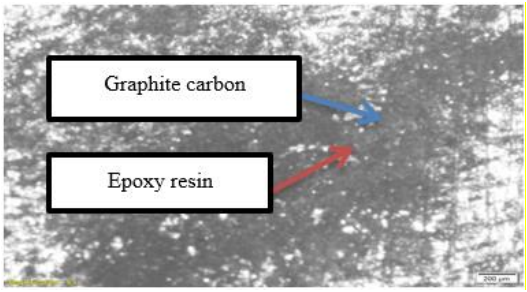


Figure 4. Microstructure of 70% graphite and 30% epoxy resin

The observation of the microstructure of specimen 80:20 is shown by figure 5. Higher composition of the graphite at 80% and lower epoxy resin at 20% cause better surface and particle's distribution. This specimen has the best distribution of particles and smoothest surface among all the specimens. While the epoxy resin did bind the aluminum and graphite, it is the increasing concentration of graphite that affect the distribution of particles and also the surface quality.

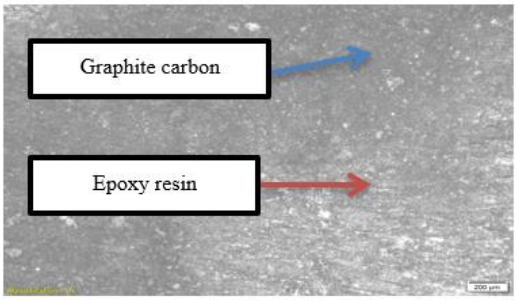


Figure 5. Microstructure of 80% graphite and 20% epoxy resin

Bending Test

The results of the bending test are done and table 2 below shows the value from each specimen.

Table 2. Bending test result

Composition (%)	Area (Mm^2)	Max. Force (MPa)
60 : 40	464.400	101.9
70 : 30	635.100	65.3
80 : 20	623.200	21.9

Based on the table 2 above, the lowest value of the bending test is on the specimen with composition of 80:20 with 21.9 MPa and the highest is on specimen with composition of 60:40 with 101.9MPa. Specimen 70:30 has value in between the two of 60:40 and 80:20 with 65.3MPa. Figure 6 shows the trend of the increasing value of the bending test from specimens. It is seen that the increase use of the epoxy resin will also increase the bending test value of the specimen. Significant difference of bending test value between each specimen is noted in this graph. This occurred because the epoxy resin acts as the adhesive between aluminum and graphite. Hence, the increase of the epoxy resin will increase the bending value of an aluminum plate.

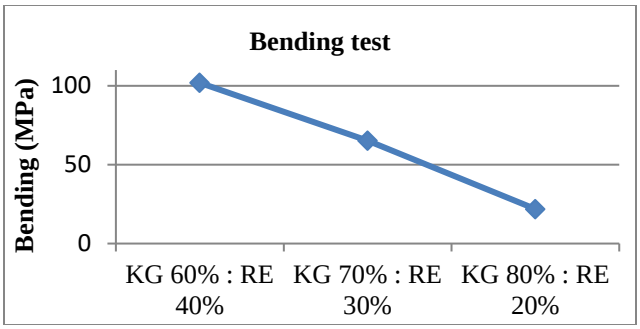


Figure 6. Bending test

CONCLUSION

In conclusion, the composition of the graphite and epoxy resin affects the electrical conductivity, microstructure and bending test of the aluminum plate. From the research, higher composition of graphite will increase the electrical conductivity, better particles distribution and surface quality. As for the epoxy resin, higher composition of it will increase the bending test value of the aluminum plate. For the future research, it is critical to find the right composition of graphite to obtain good electrical conductivity while at the same time getting good bending test value for the aluminum plate that used for fuel cell bipolar plate.

ACKNOWLEDGEMENT

The author would like to thank colleagues from the Department of Mechanical Engineering Universitas Islam Riau for supporting this research

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CERTIFICATE

No.B/801/UN34.15/DL.17/2022

CO-HOST

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5th INTERNATIONAL CONFERENCE on VOCATIONAL EDUCATION of MECHANICAL and AUTOMOTIVE TECHNOLOGY (ICoVEMAT) 2022

as presenter of paper entitled

Graphite Coating of Aluminum Bipolar Plate Using Compression Molding Method

Chairperson,

Dr. Sutiman, S.Pd., M.T.

October 6, 2022