APPLICATION OF PALM OIL FIBER-PP COMPOSITE FOR FABRICATION ON INTERIOR PART OF AUTOMOTIVE COMPONENT

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This report is submitted

in fulfillment of the requirement for degree of

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DECLARATION

I declare that this report entitled " Application Of Palm Oil Fiber-PP Composite For Fabrication On Interior Part Of Automotive Component" is the result of my own work except as cited in the references

Signature	:	....
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APPROVAL

I hereby declare that I have read this report and in my opinion this report is sufficient in term of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Design & Innovation)

Signature	:	....
Name of Supervisor	:	....
Date	:	....

DEDICATION

At first dedicating this report to Almighty Allah S.W.T, without His mercy and sympathy I was not able to accomplish this report. I also dedicate this report to my loving parents, Mr. Saidin Bin Yahya and Mrs Sarifah Binti Hamid and all my siblings whose have always been a source of strength for me.

ABSTRACT

This study investigates the mechanical and physical properties of high impact polypropylene composite reinforced with palm oil fiber. Palm oil fiber was undergo chemical treatment which is alkaline treatment to improve the properties the fiber. Less than 10 mm length of fiber is used with four different fiber loading of PO (10, 20, 30, and 40 wt%) for composite fabrication. The fabrication of composite was conducted by hot press technique. The test that involved in order identify the effect of fiber loading were tensile test, hardness test, density test and scanning electron microscope (SEM). The results of test showed that the PO-PP composite with the 10 wt% fiber loading achieved the highest values of maximum load, tensile stress and tensile strain (extension) which is 1162.21 N, 23.25 MPa, and 0.03624 mm respectively. Meanwhile, for hardness and density, PO-PP composite with 40 wt% fiber loading achieved the highest value which is 64 and 0.997 g/cm^3 respectively. The results is influenced by alkaline treatment that change the mechanical properties of the PO-PP composite.

ABSTRAK

Kajian ini mengkaji sifat-sifat mekanikal dan fizikal komposit "polypropylene" (PP) berimpak tinggi diperkukuh dengan gentian kelapa sawit. Gentian kelapa sawit menjalani rawatan kimia iaitu rawatan alkali untuk meningkatkan sifat-sifat gentian. Kurang daripada 10 mm panjang gentian digunakan dengan empat ratio gentian kelapa sawit (PO) yang berbeza (10, 20, 30, dan 40% berat) untuk fabrikasi komposit. Pembuatan komposit telah dijalankan dengan menggunakan teknik pemanasan mampat. Ujian yang terlibat bagi mengenalpasti kesan beban gentian terhadap komposit adalah ujian tegangan, ujian kekerasan, ujian ketumpatan dan pengimbas elektron mikroskop (SEM). Keputusan ujian menunjukkan bahawa komposit PO-PP dengan 10% berat gentian mencapai nilai tertinggi dalam beban maksimum, tegasan tegangan dan tarikan tegangan (pemanjangan) iaitu 1162.21 N, 23.25 MPa, dan 0.03624 mm masing-masing. Sementara itu, untuk ujian kekerasan dan kepadatan, PO-PP komposit dengan 40% berat gentian telah mencapai nilai tertinggi iaitu 64 dan 0.997 g/cm3 masing-masing. Keputusan dipengaruhi oleh rawatan alkali yang mengubah sifat-sifat mekanik komposit PO-PP.

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LIST OF ABBREVIATION

ASTM	American Society for Testing and Material
PP	Polypropylene
PO	Palm Oil
PO-PP	Palm oil-Polypropylene
PE	Polyethylene
PVC	Polyvinyl chloride
HPP	Homopolymer polypropylene
CPP	Copolymer polypropylene
NaOH	Sodium hydroxide
OPF	Oil palm frond
EFB	Empty fruit bunch
OPT	Oil palm trunk
POME	Palm oil mill effluent
UTeM	Universiti Teknikal Malaysia Melaka
SEM	Scanning Electron Microscope
TEM	Transmission Electron Microscope
MDF	Medium-density fibreboard

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CHAPTER 1

INTRODUCTION

1.1 Background

Energy efficiency is one of the important thing that need to be considered when to purchase any car. High energy efficiency can reduce fuel consumption of the car and at the same time can save money. There are a variety ways to improve energy efficiency of cars. The use of lightweight materials is become revolution in automotive industry. By using lightweight material, less energy is needed to accelerate the car compared to the heavier one.

Nowadays plastic is the one of the material that widely used in order to achieve sustainability and better fuel consumption in automotive industry. The use of plastic in manufacture of cars can reduce weight, prevent corrosion, increase the toughness and give high performance at low cost (Katarina). Plastic or polymer can be classified into two type which are thermoplastic and thermoset . Thermoplastic is often used in automotive field because of their properties that can give high-performance. Polypropylene, (PP) is a type of thermoplastic that is growing rapidly in thermoplastic (V.Selvakumar el. al, 2010).

Natural-fibre-reinforced polymer composite is a combination between high strength fibre and polymer (H Ku el. al). Natural fibre reinforced composite is used in automotive industry due to their characteristic that suitable in automobile part (Carus et al.,2010).

1.2 Problem Statement

Nowadays thermoplastics is widely used in automotive manufacture to make cars more energy efficient. In order to fulfil the target, less weight material with high capability is needed. Polypropylene is one of the thermoplastic that always been used that can gives high performance but still high in cost. Composite mixture between polypropylene and palm oil fiber are to test the physical and mechanical properties whether can give light weight material with high ability to the interior part of automotive.

1.3 Objectives

The propose of this project are as follow:

1. To compare of different percentage of fiber on physical and mechanical properties of Palm Oil-Polypropylene, (PO-PP) composite
2. To analyze the microstructure of PO-PP composite by using Scanning Electon Microscope

1.4 Scope of Project

The scopes of this project are:

1. The length of palm oil fiber used is less than 10 mm.
2. The physical test for PO-PP composite only cover hardness test (ASTM D2240), density test (ASTM D792) and Scanning electrom microscope (SEM).
3. The mechanical test only cover tensile test (ASTM D3039).
4. The ratio of weight percentage used is 10:90, 20:80, 30:70 and 40:70. The total weight of the sample is 16g

CHAPTER 2

LITERATURE REVIEW

2.1 Polymer

In general, polymer can be classified into three type of: lastomers, thermosetting polymer and thermoplastic polymer. Elastomers are known as elastic materials or rubbers. Thermosetting polymer such as epoxy is type of plastic that only can be shape once when heated. Unlike thermosetting polymer, thermoplastic polymer can be melted or softened by applying heat and solidified when cooled repeatedly (Biron, 2007). In this project focused on the thermoplastic polymer. The advantages of usage of thermoplastic are: (1) they can be recycle and re-process (Ferreira, et al 1997 , Greco, et al, 2007, Ishak, et.al 2007) , (2) thermoplastic is naturally more stronger than thermoset and make it resistant to low velocity impact (Trudel-Boucher, et al. 2006), (3) the process quite simple, faster, safe and eco-friendly (Ferreira, et al 1997), (4) crosslink does not occur when processing the thermoplastic (Campbell, 2006), (5) can be formed into various shape (Lauren, n.d), (6) has low water absorption (Greco, et al, 2007). Polyethylene (PE), Polyvinyl chloride (PVC), Polypropylene (PP) are example of the thermoplastic polymer.

2.1.1 Polypropylene

Polypropylene (PP) is one types of thermoplastic polymer that widely used in various applications such as in automotive industry, packaging, and textiles (K. Vijaya, et al 2013, Creative Mechanism, 2016). In 1951, Paul Hogan and Robert Bank, the scientists of Philips petroleum were the first people discover the PP followed by Natta and Rehn, German scientist. (Creative Mechanism, 2016). PP become the preferred choice in many industrial application due to the its characteristics: (1) low density (Greco, et al, 2007), (2) high fatigue resistance, (3) high chemical resistance which not react easily with the PP (Creative Mechanism, 2016), (4) high impact strength, and (5) low coefficient of friction. There are two types of polypropylene: (1) homopolymer polypropylene and (2) copolymer polypropylene (Creative Mechanism, 2016). Some of typical properties of PP are shown in Table 2.1.

Table 2.1: Common Properties of Polypropylene (Source: International association of plastic distribution, iapd , http://www.sdplastics.com/pdf/pp.pdf)

ASTM	Property	HPP	CPP
D792	Specific gravity	0.90-0.91	0.89-0.91
D570	Water absorption %	0.01-0.03	0.03
C177	Thermal conductivity (10^4 cal-cm/sec-cm^2.^{o}C)	2.8	3.5-4.0
D696	Coefficient of thermal expansion (10^{-5} in/in-^{o}C)	8-10	6-10
HPP – Homopolymer polypropylene CPP- Copolymer polypropylene			

2.2 Natural Fiber

Natural Fiber is a material that come from plant or animal that widely used as reinforcement in polymer composite. Natural fiber becomes high demand in industrial application due to their advantages especially plant fiber (Mohd Amran, 2014). The Advantages of natural fiber: (1) low in cost, (2) low density (Munirah, et al, 2007), (3) light in weight, (4) acceptable specific properties, (5) can reduce tool wear (Munirah, et al, 2007, Layth, et al,2015), and (6) renewability (Suardana, 2010). The use of natural fiber depend on their function because fibers may be located at difference region of the plant (Tanja,2010). Natural fiber can be outstanding materials and can replace the existing expensive material and non-renewable synthetic fiber (Munirah, et al, 2007). However, natural fibers are not problem-free alternative because of the composition of cellulose, hemicellulose, lignin and waxy substances at their structure. This composition allow the fibers absorb the moisture at surrounding. The unwanted absorption may lead to the weak bonding between fiber and matrix material (Layth, et al,2015). Weak bonding can caused stress transfer throughout the interface not effectively.

2.3 Chemical Treatment

To overcome the bonding problem, chemical treatment should be conducted to the surface of the fiber (Layth, et al,2015). There are few chemical treatment that have been tested from previous research and used to remove the unwanted thing at the surface of the fiber such as lignin and hemicellulose. Alkaline treatment and Silane treatment are example of the chemical treatment. The effect of the chemical treatment for certain natural fiber is summarized in Table 2.2.

Table 2.2: The previous works on treated natural fiber reinforced polymer composite (Layth, et al,2015)

Fiber-matrix composite	Treatment	Effect on composite
Banana/epoxy	Alkaline treatment	Better mechanical properties
Sisal-oil palm/natural rubber	Alkaline treatment	Tensile strength of the epoxy composites were increased
Jute/epoxy	Silane treatment	Increase shear strength. Increase the tensile and flexure properties
Sisal fiber/epoxy	Silane treatment	Reducing the intake of moisture by fiber
Bleached soda pulp fiber/ epoxy	Silane treatment	Improve the mechanical properties and reduce water absorption.
Sisal fiber /epoxy-unsaturated polyester polymer mortars	Acetyl treatment	Increase adhesion between fiber and matrix

2.3.1 Alkaline Treatment

Alkaline treatment is the most effective method to advance the properties of the reinforced natural fiber composite (Rosa et al, 2009). Alkaline treatment can improve bonding of the fibre-matrix. Besides, this treatment can eliminate unwanted impurities that can caused low performance of the composite. Hydrogen bonding in cellulose hydroxyl group of the fiber may also destroy (Munirah, et al, 2007) . Lignin and pectin of single hemp fibers are removed after undergo the treatment (Sgriccia, 2008). Sodium hydroxide (NaOH) is used in this treatment. The concentration of the NaOH affects surface of the fiber. The higher the concentration, the lower the density of the fiber. The weight of the fiber also decrease because of removal of lignin, pectin and others unwanted substance at the surface (Suardana, 2010).

2.4 Palm Oil Tree

Oil Palm is one of the valuable product of Malaysia. Oil palm tree has 7 to 13 m height and 0.45-0.65m in diameter. Almost 50% of the oil palm production is from Malaysia. Oil palm tree usually have the life expectancy about 25 years and contributes to high amounts of waste in Malaysia. Oil palm biomass cover 50% cellulose, 25% hemicellulose, and 25% lignin in their cell wall. The waste of the palm oil includes oil palm frond (OPF), empty fruit bunch (EFB), oil palm trunk, (OPT) and palm oil mill effluent (POME). (Abdul Khalil, et al. 2012).

Figure 2.1: Palm Oil Tree (Source: Abdul Khalil, et al. 2012)

2.4.1 Empty Fruit Bunch (EFB)

Oil palm fiber is one of the natural fiber with high demand because they are renewable nature and has high potential to be reinforced composite (Mohd Amran, 2014, Abdul Khalil, et al. 2012). There many usage of palm oil fiber such as: (1) food supplement for animal, (2) organic fertilizer for plant, (3) reinforcement of composite (Layth, et al,2015), and (4) alternative boiler fuel. Oil palm produce high amount of oil palm biomass such as palm frond (OPF), empty fruit bunch (EFB), oil palm trunk, (OPT) and palm oil mill effluent (POME). EFB is an asset which can possibly be utilized for power generation, now , it is not being used. EFB are abandoned after product of the oil palm collected for oil refining. The amount EBF that consistently released from palm oil refineries are 12.4 million tons/years (net weight). As natural fiber resource, EFB has high amount of cellulose. Amount from the total biomass of oil palm produced of EFB is only 10 %. For oil palm fronds (OPF) and oil palm trunk (OPT) are 70% and 5% respectively. Previous researcher showed that oil palm fibers have capability to be reinforcement in polymer composite. (Abdul Khalil, et al. 2012). The usage of EFB, OPF and OPT is shown in Table 2.3.

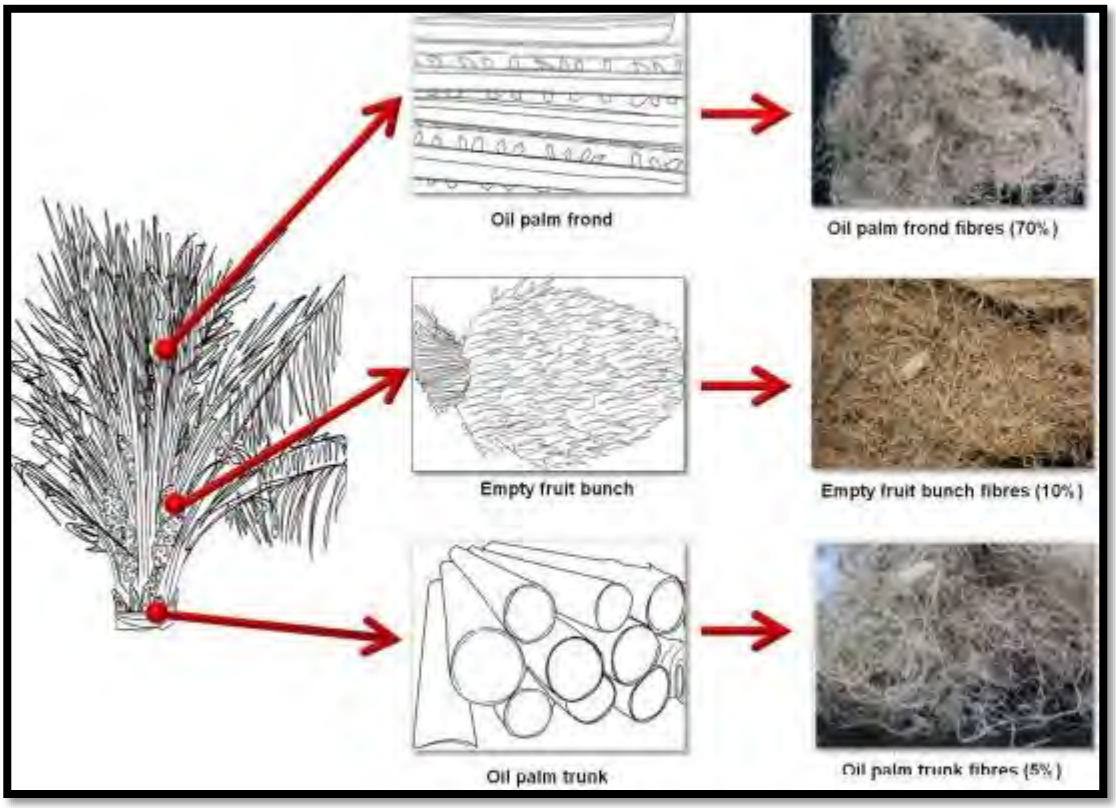

Figure 2.2 : Oil palm biomass and their fiber (Source: Abdul Khalil, et al. 2012)

Table 2.3: The application of oil palm fibers (Source: Abdul Khalil, et al. 2012)

Fiber	**Product**
Oil palm EFB fibers	MDF
	Polymer biocomposite
	Hybrid composite
	Plywood
	Particle boards
	Biofuel
Oil palm frond fibers	Paper
	Nutrient recycling
	Fibreboard
	Biodegradable film
	Animal supplement (food)
	Downdraft feed
Oil palm trunk fibers	Lignin
	Plywood