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 : ....

Name : Nur Hidayah Binti Saidin

Date : ....

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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In the name of Allah the Most Gracious Most Merciful.

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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

LIST OF APPENDICES

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.

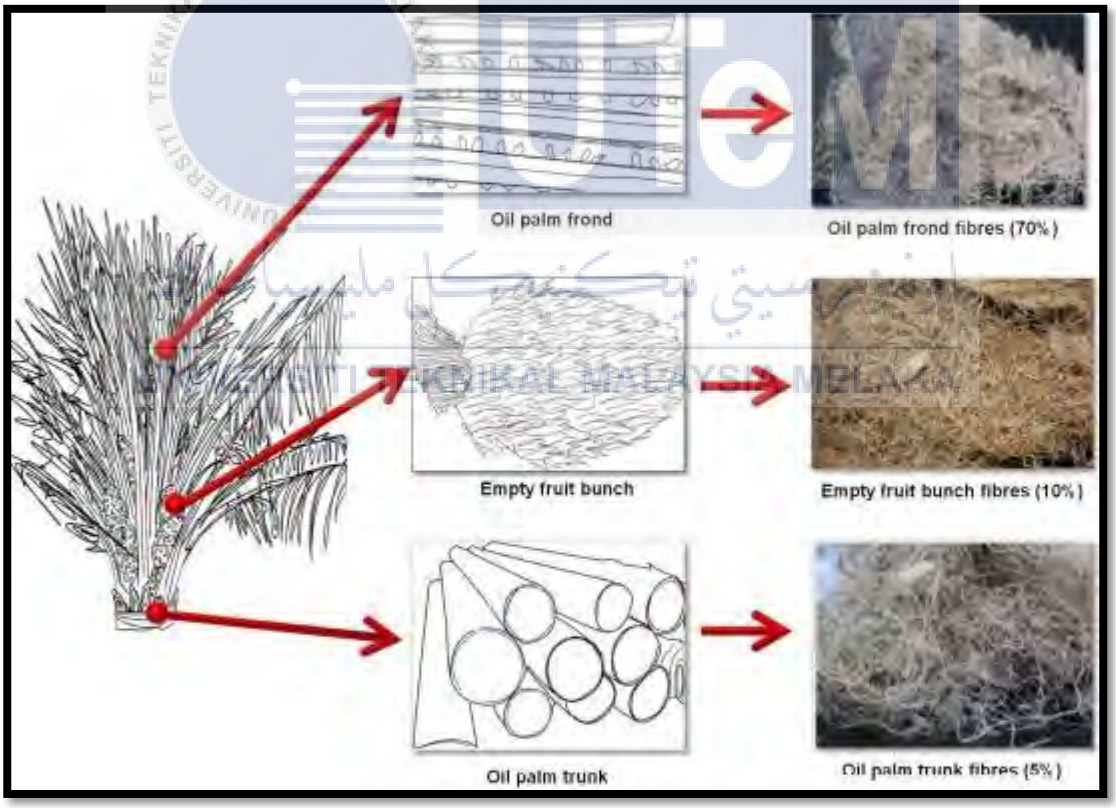


Figure 2.2 : Oil palm biomass and their fiber (Source: Abdul Khalil, et al. 2012)

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

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter explains the methods used in completing this study. There are two main parts in this chapter which are preparation of sample and sample testing. There are four steps in sample preparation process. This study is focused on tensile test, hardness test, density test and scanning electron microscope (SEM). The flow chart of the project is shown in Figure 3.1.

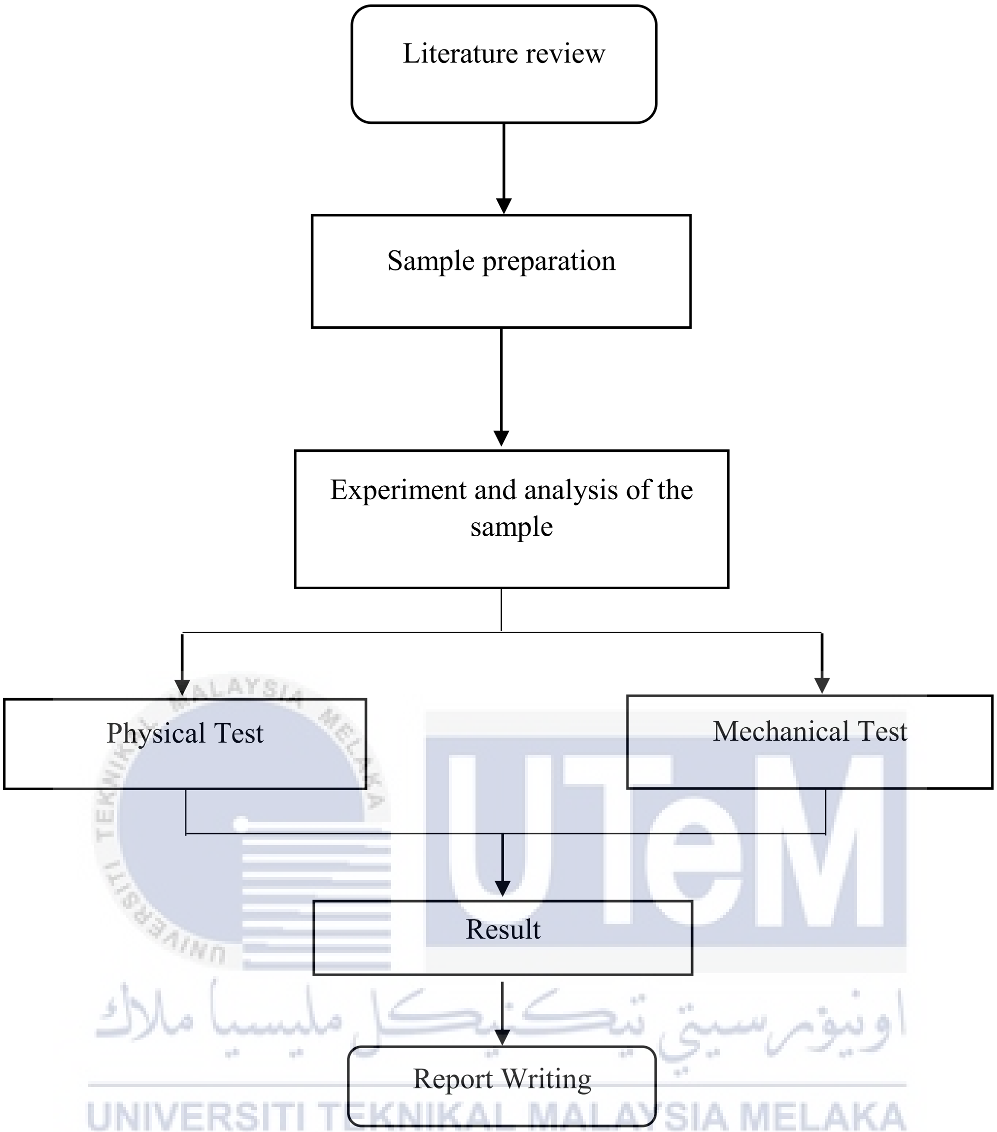


Figure 3.1: Flow Chart of Methodology

3.2 Sample Preparation

In order to analyse the application of palm oil fiber-polypropylene (PO-PP) composite, four sets of sample is prepared with different weight percentage ratio of palm oil fiber. The ratio of palm oil used in this project are 10% , 20% , 30% and 40% wt of the composite.

3.2.1 Grinding Process of Polypropylene

This aim of this process is to crush the PP up into powder. The raw PP is in the form of granules. HUYU GM/F2000-1 Pulverizer (High Manganese Grinding Bowl) machine at Non-Destructive Testing & Composites Laboratory, UTeM is used to crush the PP. Initially, the PP is weighed less than 20g before being put into the pulverizer bowl. To achieve a satisfactory results of PP powder, the maximum weight of PP that can put into the pulverizer bowl is less than 12g. 1000 seconds time is set on the pulverizer machine to grind the PP. The grinded PP then is blended again by using Philips blender to get the best form of PP powder. The PP powder is sifted by using filter to obtain a uniform size of powder.

(a) (b)

Figure 3.2: (a) and (b) : HUYU GM/F2000-1 Pulverizer (High Manganese Grinding Bowl) machine at Non-Destructive Testing & Composites Laboratory, UTeM

Figure 3.3 : Weighing of PP

Figure 3.4 : Result of The Grinded PP

Figure 3.5 : Grinding of PP By Using Philips Blender

Figure 3.6: Sieve Process

Figure 3.7: Result of The PP Powder

3.2.2 Chemical Treatment

The treatment that conducted for the palm oil fiber is alkaline treatment. This treatment involve a procedure of soaking the palm oil fiber in NaOH solution with the concentration of 5% at room temperature for 2 hours. The next process of this treatment is wash the soaked palm oil fiber with distilled water to remove excess of NaOH. The final procedure of this treatment is put the fiber under the sunlight for few hours to ensure the fiber totally dry. After undergo the alkaline treatment, the palm oil fiber is chopped with a size of less than 10 mm.

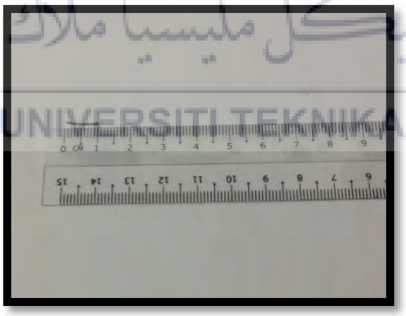
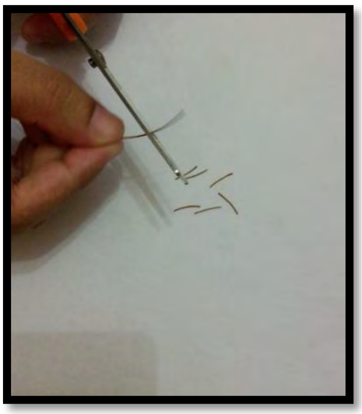
Figure 3.8: Oil Palm Fiber Before Treatment

The process of Alkaline Treatment

Table 3.1: The Process of Alkaline Treatment

Process	**Description**
1.  	• Sodium hydroxide (NaOH) is put in beaker and is weighed • 30g of NaOH is used

2  	• Next, 30g of NaOH is mixed with little distilled water to dissolve the NaOH • 6 litre of distilled water is used in order to get 5% concentration of NaOH solution
3 	• Palm oil fiber is fully immersed into the NaOH solution • Palm oil fiber was soaked for 2 hours

4 	• After 2 hours, palm oil fiber is washed using distilled water to remove impurities and excess NaOH
5 	• Next, palm oil fiber is dried under the sunlight for few hours till the fiber is totally dry
6  	• After the fiber is totally dry, the fiber is chopped into a size less than 10 mm

3.2.3 Composite Fabrication

The PP powder and chopped palm oil fiber is mixed together. The total weight of the mixture is 16g . Four weight ratio of palm oil fiber-PP mixture that have been used are 10:90, 20:80, 30:70, and 40:70 (w/w). The samples are fabricated by using GOTECH hot press machine (Motorise Hydraulic Molding Test Press) at Non-Destructive Testing & Composites Laboratory, UTeM. Firstly, the mixture is put into 160 mm x 40 mm square of steel mould. Then, preheat the mould at temperature 170^{o}C for 5 minutes. This step is to ensure heat transfer flow effectively. The mould is heated again at the same temperature under 25 kg/cm^2 of pressure for 5 minutes then cold press for 15-20 minutes..

Table 3.2: Composition of the Palm Oil Fiber-PP

PO/PP (w/w) %	Palm Oil Fiber (g)	Polypropylene (g)
10/90	1.6	14.4
20/80	3.2	12.8
30/70	4.8	11.2
40/60	6.4	9.6

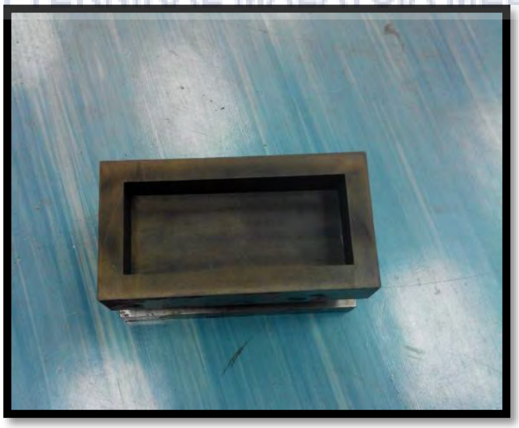


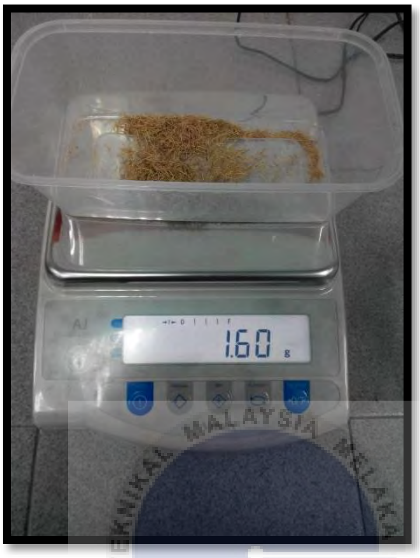
Figure 3.9: 160 mm x 40 mm Square of Steel Mould

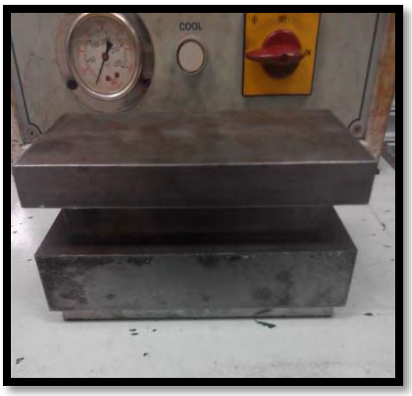
Figure 3.10: GOTECH hot press machine (Motorise Hydraulic Molding Test Press) at Non-Destructive Testing & Composites Laboratory, UTeM

Figure 3.11: H Type Hydraulic Press Machine

The process of Composite Fabrication :

Table 3.3: The Process of Composite Fabrication

Process	Description
1 	• Chopped palm oil fiber is weighed according to the predetermined ratio
2 	• Next, mix the PP powder until the total weight is equal to 16 g • For precaution, PP powder is put more to ensure when undergo the compression process does not change the total weight of sample

3 	• Shake the mixture of PP powder and PO fiber to make sure it mixed well
4 	• The mixture is put into 160 mm x 40 mm Square of Steel Mould
5 	• The cover is put carefully

6 	• The mould undergo preheat process for five minutes • Temperature : $170^{o}C$ • Pressure : 0 kg/cm^2
7 	• After 5 minutes preheat, the mould is compressed for 5 minutes • Temperature : $170^{o}C$ • Pressure : 25 kg/cm^2
8 	• After compression process, the mould undergo cooling process for 15-20 minutes

9  	• The sample is removed from the mould by using H Type Hydraulic Press Machine

10	
	• One of the sample that has been prepared

3.3 Sample Testing

There are two types of testing that have been run to the palm oil fiber-PP composite sample which are mechanical and physical test according the ASTM standard.

3.3.1 Tensile Test

The purpose of tensile test is to determine the ability of PO-PP composite sample to withstand the load that pull the sample apart. This project is focused on the tensile strength of the palm oil fiber-PP composite. The tensile strength is compared among the four different fiber composition. This tensile test is referred to the ASTM D 3039 : Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials. The size of the samples that has been used is 140 mm x 25 mm x 3 mm (length x width x high). This test is conducted by using Instron Universal Testing Machine. The Instron Universal Testing Machine is controlled by Bluehill 2 software at constant speed which is 2 min/mm. The sample is placed in the gripper of the testing machine and load is applied till rupture surface on the sample occurred. The data is automatically recorded including the Maximum Load

(N), Tensile Stress at Maximum Load (MPa), Tensile Strain (Extension) at Maximum Load (mm/mm) and Extension (mm).

Figure 3.12: 140 mm x 25 mm x 3 mm of PO-PP Composites (from left:10/90,20/80,30/70 w/w)

Figure 3.13: Instron Universal Testing Machine

Figure 3.14: Position of the sample on the gripper

3.3.2 Hardness Test

Hardness test is run to the samples of PO-PP composite with different weight percentage ratio to determine the hardness of the composite to resist the deformation. The standard used in this test is ASTM D2240: Standard Test Methods for Rubber Property: Durometer Hardness. The test is conducted by using analogue Shore scale "D" type Durometer at Non-Destructive Testing & Composites Laboratory, UTeM. The Shore-D is same with other hardness test which is measure the depth of sample at the flat surface. By referring the ASTM D2240, the measurement of the initial hardness is allowed. The result of all sample is compared.

Figure 3.15: Analogue Shore scale “D” type Durometer

Figure 3.16: Sample of PO-PP Composite is tested by using Shore-D Durometer

3.3.3 Density Test

Density test is carried out based on ASTM D792: Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastic by Displacement. The purpose of this test is to determine and compare the density of each samples. Density test can be classified into two method, Test Method A and Test Method B. According to the standard method for density, Method A use water to test solid plastic while method B use liquid other than water. Based on the standard procedure, density test is started by determine the mass of each sample. After that, the sample is immersed in a liquid (depends on the method choose) and determine the mass of immersion sample. Finally calculate the relative density. For this study, Method A is used. Density test is conducted by using Electronic Densimeter (MD-300S).

Figure 3.17: Electronic Densimeter

3.3.4 Scanning Electron Microscope (SEM)

SEM is further advancement of the transmission electron microscope (TEM). SEM is used to observe the interaction and miscibility between palm oil fiber and polypropylene by generate a beam of electrons. The advantages of using SEM: (1) the image more realistic, (2) high focus, and (3) easy to handle. JEOL JSM-6010PLUS/LV type of SEM is used. The result of structure of four different weight ratio percentage is compared. (Mohd Amran). Before the sample is put into SEM, four different ratio of sample is cut in to 10mm x 10mm. Then, the sample were placed on a stub, coated with platinum. Next, the sample is inserted into scanning barrel. The inside of scanning barrel is vacuumed to avoid intrusion of scanning picture due to the present of air. After coating process, the samples is put into the chamber of the SEM. The result of the scanning is obtained from microscope software. Three types of magnification size is taken for every samples which are x40, x100 and x200.

Figure 3.18: JEOL JSM-6010PLUS/LV Scanning Electron Microscope

Figure 3.19: Coating Process

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

This chapter explains the results of the tensile test, hardness test, density test and scanning electron microstucture analysis that have been carried out on four different ratio of PP-palm oil fiber composite. To facilitate testing, four different ratio is labeled as in Table 4.1.

Table 4.1: Label of the four different ratio

Label	Ratio (wt%)
A	10/90
B	20/80
C	30/70
D	40/60

4.2 Mechanical Properties

Figure 4.1 shows the maximum load with different PO loading for PP-PO composite. A: 10 wt% of PO loading has reached maximum load up to 1162.21 N. The maximum load decreases with increasing of PO loading. D: 40 wt% of loading has achieved the lowest maximum load which is 752.82 N. Figure 4.2 shows the tensile stress at maximum load for each PO loading. The highest tensile stress at maximum load is up to 23.25 MPa at 10 wt% loading of PO. The trend of the graph is similar with Figure 4.1 which is decreases with increasing of PO loading. The 40 wt% of PO loading decreased the tensile strength by 64.77% compared to the 10 wt% of PO loading. The decreasing of the tensile strength might be due to the effect of the alkaline treatment and the arrangement of the fiber in the composite. PO fiber contain cellulose, hemicellulose, lignin and other substance, this composition will allow PO fiber to has a strong bond and also allow to absorb the moisture at surrounding. Unwanted absorption will lead to weak bonding between PO fiber and matrix (Layth,et al,2015). Effect of the alkaline treatment also affects the strength of the bond between PO fiber and PP. 5% concentration of alkaline solution might be higher to PO fiber. Alkaline treatment might reduce too much cellulose and others substance that can make strong bond between PO fiber and matric. In addition, PP is material that has high tensile strength, addition of treated PO fiber will affect the mechanical properties of PP . PP is not very reactive because of non-polar nature of the molecule. This may leads the problems to form bonding between PP and PO fiber (A.R, et,al 2005).

Table 4.2: Result of the Tensile Test

Composite	Maximum Load (N)	Tensile Stress at Maximum Load (MPa)	Tensile Strain (Extension) at Maximum Load (mm/mm)	Extension (mm)
A	1162.21	23.25	0.03624	4.97012
B	997.03	19.94	0.02726	2.89602
C	881.11	15.70	0.02091	2.71253
D	752.82	15.06	0.01744	2.49938

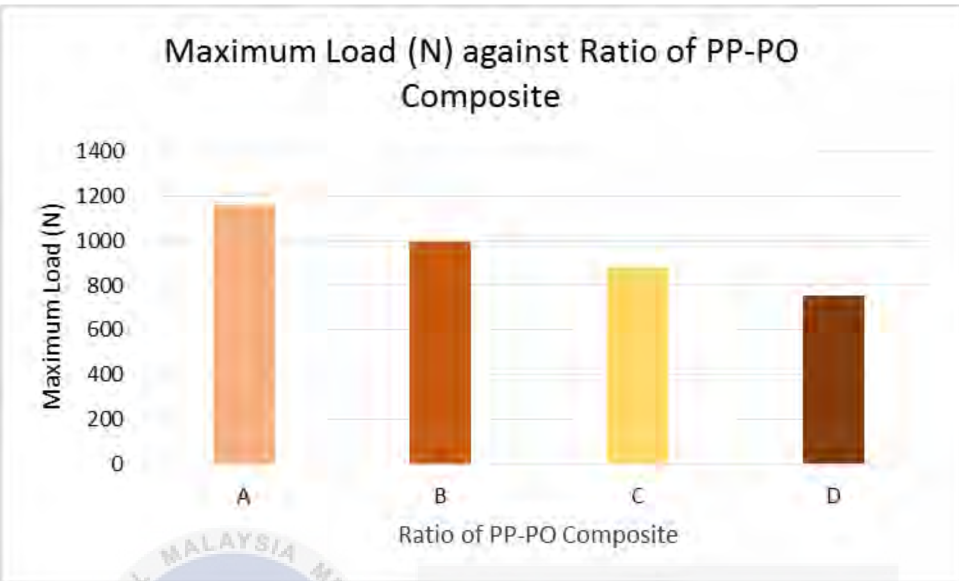


Figure 4.1: Maximum Loading (N) against Ratio of PP-PO Composite (%)

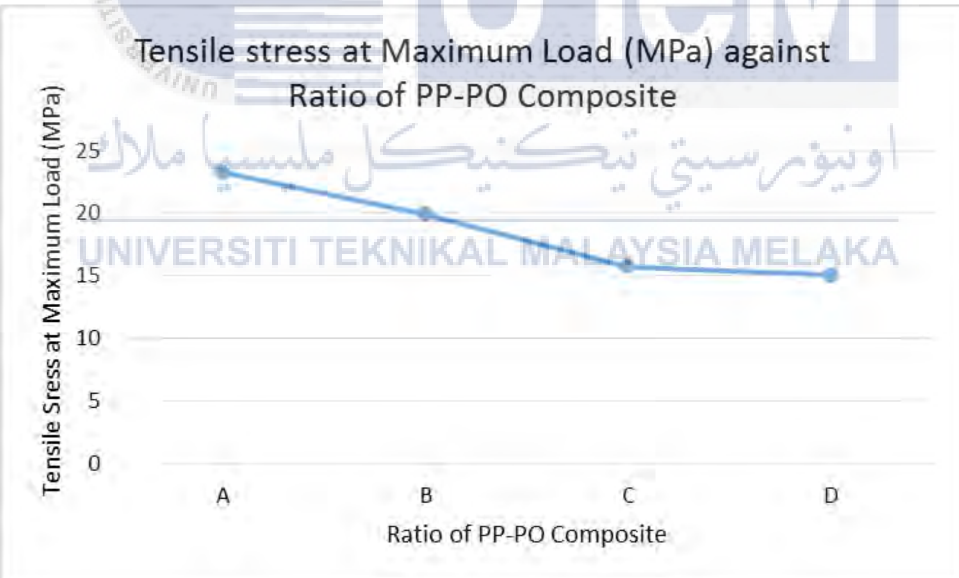


Figure 4.2: Tensile Stress at Maximum Load (MPa) against Ratio of PP-PO Composite (%)

From Figure 4.3 shows that the extension of four sample increase with the increment of load.. The extension is related to the tensile stress. Low tensile stress will give minimum extension. Less PP also affect the extension because the increment of PO fiber caused the elasticity of the composite becomes decrease. The tensile strain also effected by tensile train. Figure 4.4 shows that the tensile strain increase with the increment of tensile stress. PO-PP composite with 10 wt% loading of PO achieved the highest value for extension and tensile strain.

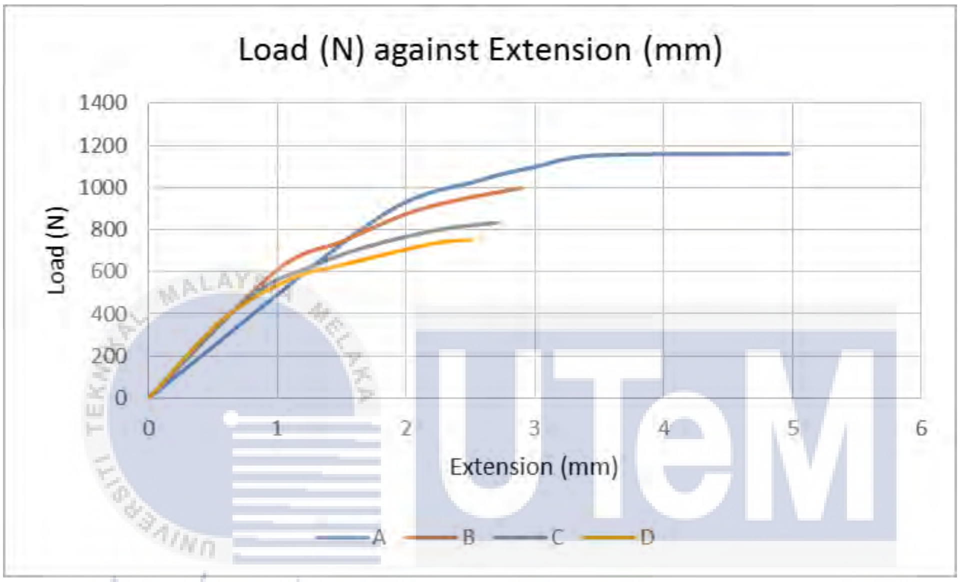


Figure 4.3: Load (N) against Extension (mm)

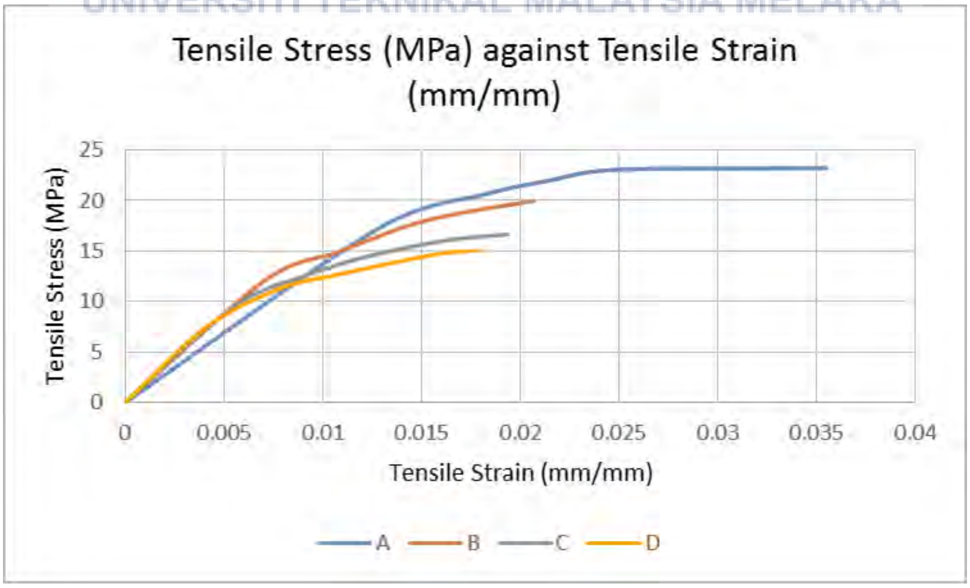


Figure 4.4: Tensile Stress (MPa) against Tensile Strain (mm/mm)

4.3 Physical Properties

Meanwhile, Figure 4.5 and Figure 4.6 shows the graph of hardness and density (g/cm^3) against ratio of PP-PO composite respectively. From both graph shows the hardness and density increase with the increment of PO loading. The density of the composite increased due to the compact packing of the fiber. 40 wt% of loading has achieved highest density up to 0.997g/cm^3 . More fiber means less PP. One of the characteristic of PP is low in density. Less PP caused the density of the composite becomes greater. For the hardness, 30 wt% and 40 wt% of PP loading has similar value which is 64. More PO fibers caused the composite become compact and hard. The composite also become less elastic and brittle.

Table 4.3: Results of Density and Hardness

Composite	**Density (g/cm^3)**	**Hardness**
A	0.993	63
B	0.993	63.6
C	0.995	64
D	0.997	64

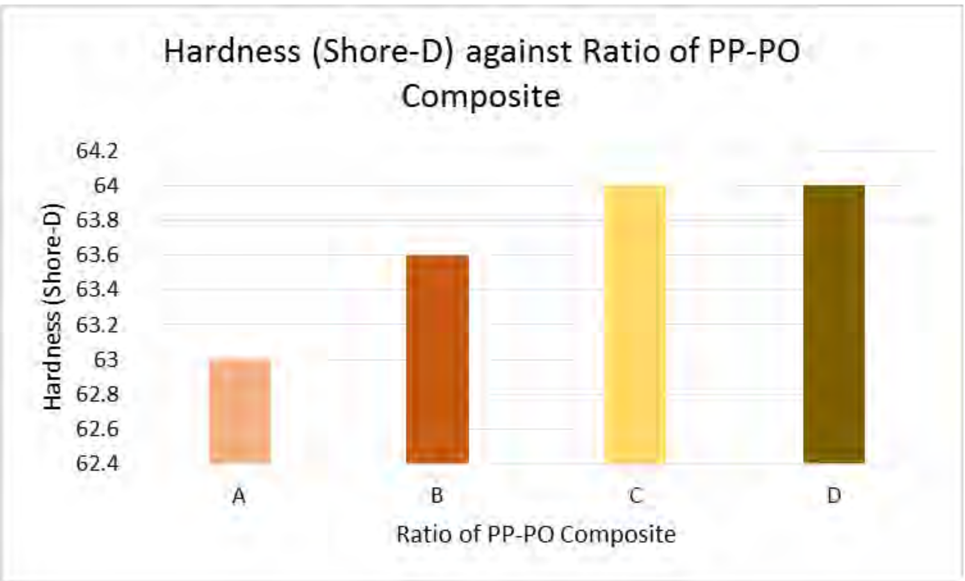


Figure 4.5: Hardness (Shore-D) against Ratio of PP-PO Composite

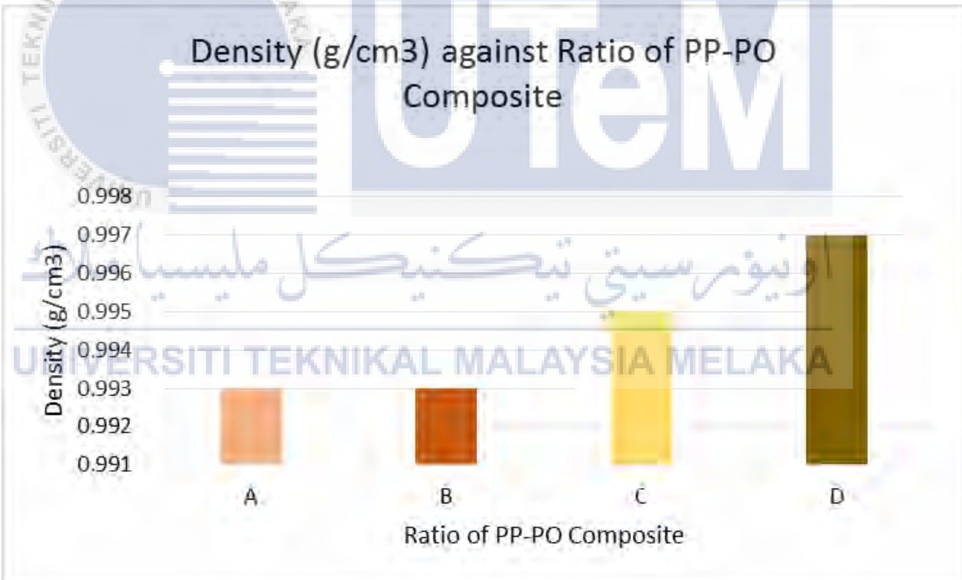


Figure 4.6: Density (g/cm^3) against Ratio of PP-PO Composite

Figure 4.7 shows that the magnification x40 by using Scanning Electron Microcope (SEM) of four different ratio. The arrangement of PO fiber in this composite is clutter arrangement. There are distances between fibers at (a) because this composite has low PO loading compared to (d) which more compact. For (c) the mixture between PO fiber and PO is uneven.

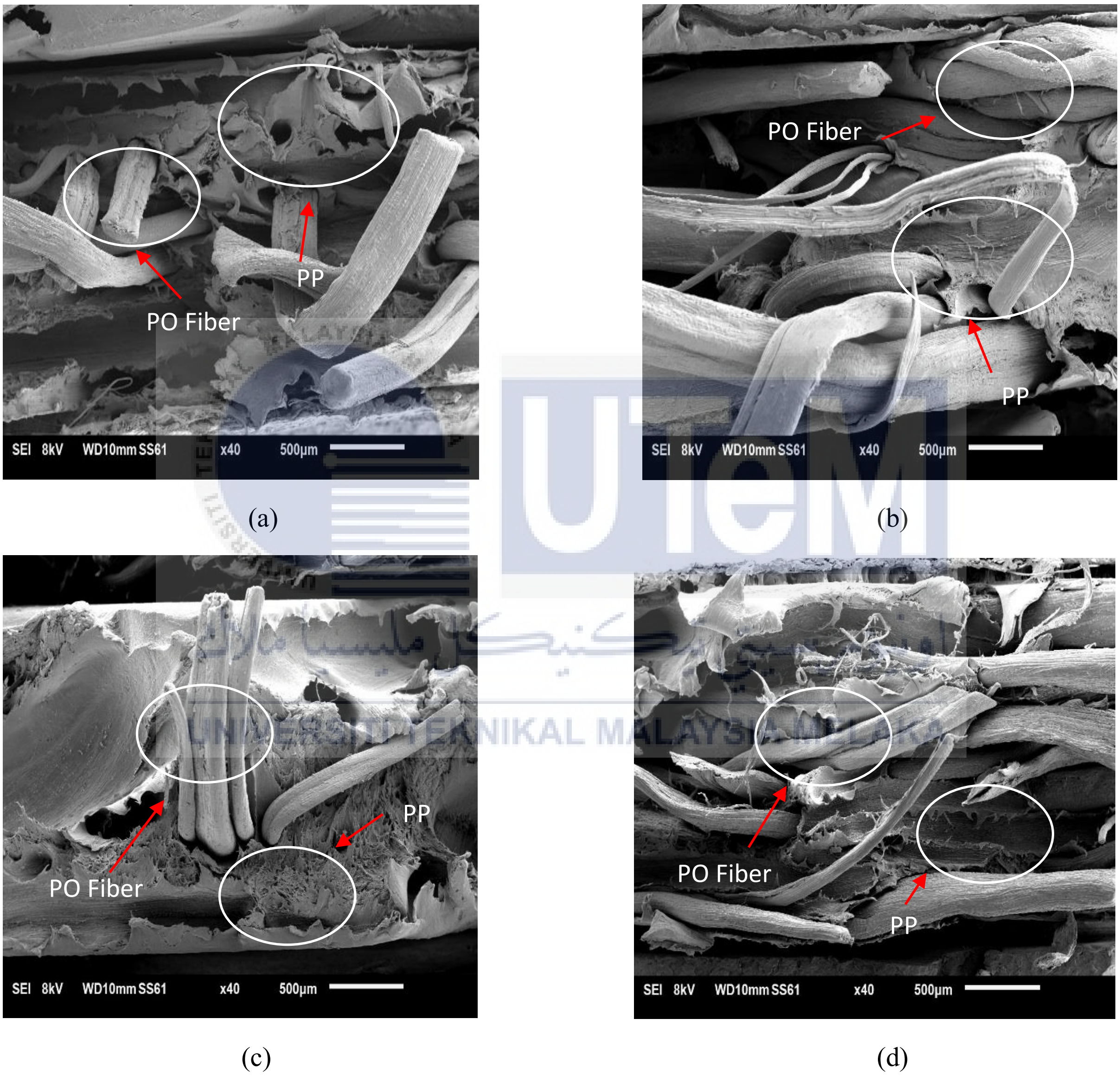
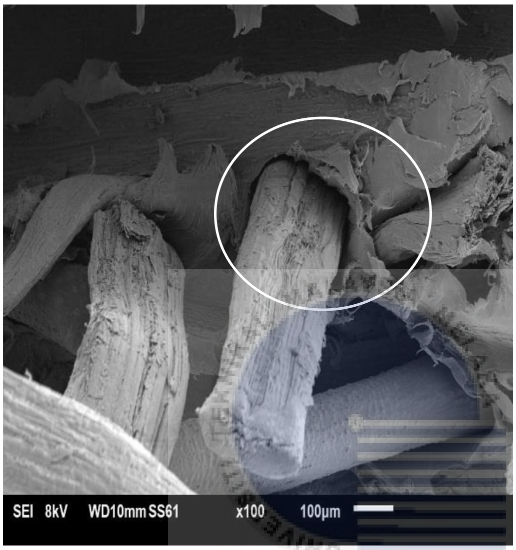
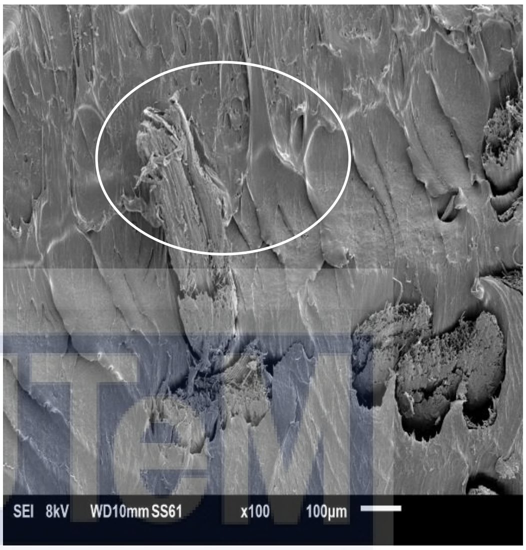


Figure 4.7: Magnifications x40 of (a) A:10/90, (b) B: 20/80, (c) C : 30/70 and (d) D: 40/60

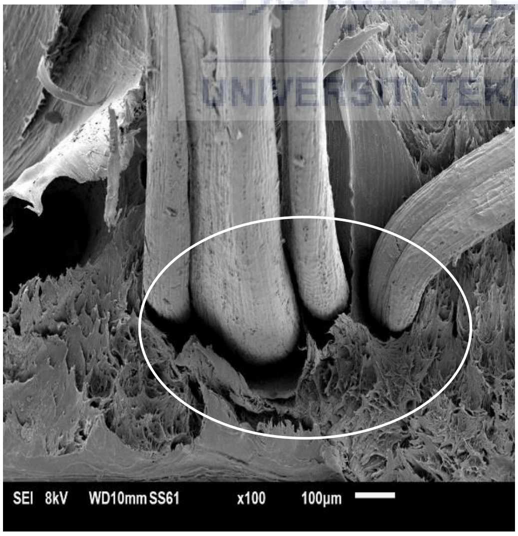
Figure 4.8 shows images of SEM with magnification x100. For (a), shows that the bonding between PO fiber and PP are strong. The result is related to the tensile strength since 10 wt% has higher tensile strength compared to the others ratio. The bonding decrease with the increment of PO loading. The microstructure of 40 wt% of PO loading shows that the bonding between PO fiber and PP are weak. The tensile stress also low compared to the others three ratio.



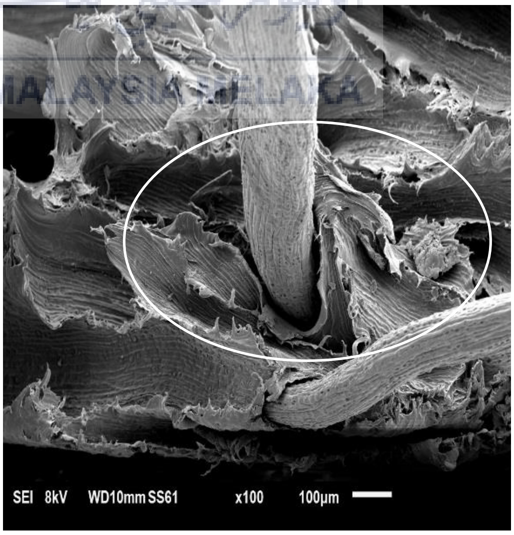
(a)



(b)



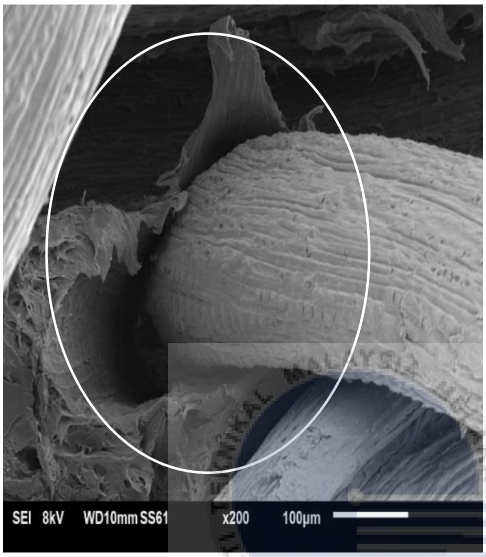
(c)



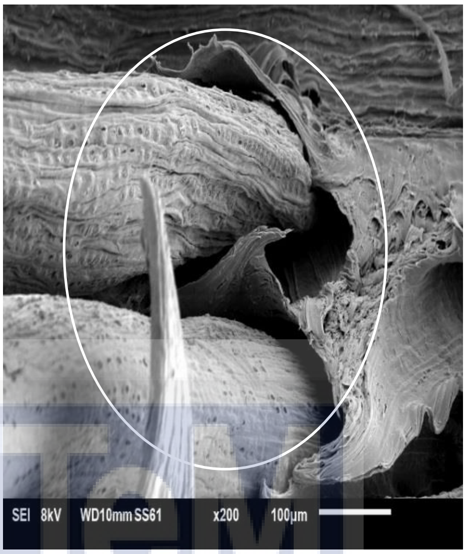
(d)

Figure 4.8: Magnification x100 of (a) A:10/90, (b) B: 20/80, (c) C : 30/70 and (d) D: 40/60

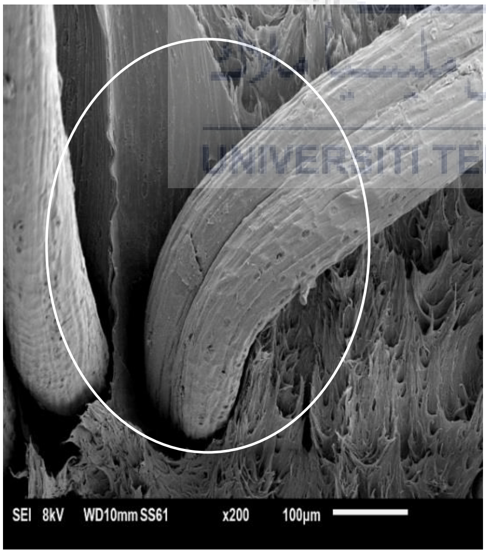
Figure 4.9 shows images of SEM with magnification x200. Microstructure of 10 wt% and 20 wt% of PO loading shows that the PO fiber is still attached to the PP after being pulled during the tensile test. For 30 wt% and 40 wt% of PO loading shows that PO fiber is drawn out from the PP. The results are related to the bonding between PO fiber and PP become weak as the PO loading increase.



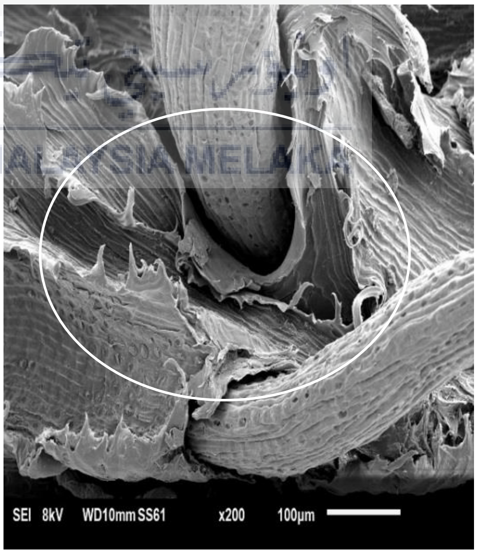
(a)



(b)



(c)



(d)

Figure 4.9: Magnification x200 of (a) A:10/90, (b) B: 20/80, (c) C : 30/70 and (d) D: 40/60

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In present study Palm-Oil fiber-polypropylene (PO-PP) composites were developed. There are ratio of PO fiber loading in term of wt% used in this study , which are 10%, 20%, 30%, and 40%. PO-PP composites were manufactured by hot compression mould process. After undergo four test which are tensile test, hardness test, density test and scanning electron microscope (SEM), the mechanical and physical properties were identified and compared for each ratio.

The result of mechanical property shows that 10 wr% loading of PO fiber achieved the highest maximum load among the others three PO loading which is 1162.21 N. The lowest maximum load is 752.82N which is belonged by 40 wt% loading of PO fiber. The maximum load is decrease with increment of PO loading. Maximum load also gives maximum tensile stress. The highest tensile stress is 23.23 MPa. One of the characteristic of PP is high tensile stress. The increment of PO fiber in the composite will decrease the tensile stress of the composite.

From the result obtained, the tensile stress also affect to the extension of the composite. The higher tensile stress the longer the extension of the composite. The extension also related to the elasticity of the composite. The higher number of fiber in the composite, the lower the elasticity of the composite. For this study the 10 wt% loading of PO has achieved the highest extension compared to the others three composites which is 4.97012 mm while the lowest elongation is 2.49938 mm for 40 wt% loading PO.

The result of the physical properties shows that the density and hardness of the PO-PP composite increase with the increment of PO fibers. For density, the result is related to the alkaline treatment that have been done to the PO fiber and also due to the compact packing. The lowest density and hardness are 0.993 g/cm^3 and 63 respectively from sample with 10 wt% loading of PO fiber. The microstructure of all composite also have been discussed based on their magnification size which are x40, x100 and x200.

Based on the physical and mechanical properties, it can be conclude that the PO-PP composite with the composition ratio 10/90 is the best composite compared to the others three composition ratios (20/80, 30/70 and 40/60).

5.2 Recommendation

Based on the study that have been made, there are few recommendations that can be suggested for future study, for example diversify the chemical treatment for fiber such as the use of many concentration solution of alkaline treatment and compare their properties. Besides, for the future study also can compare between treated and untreated fiber for the composite.

In future study, dogbone shape of sample is suggested for tensile test because it can provide more accurate data. The orientation of the fiber can be compared between parallel arrangement and distributed arrangement.

The composite fabrication, hot press is not really accurate. Suitable material and good design of mould should be prepared for future study. Injection moulding is also recommended because it more accurate and can reduce error from human factor.

REFERENCES

Renard, A. R. (2005). *Fundamentals of Fiber Reinforced composite Materials.* Institute of Physics Publishing Bristol and Philadelphia

Biron M. 2007. *Thermoplastics and Thermoplastic Composite*. Les Ulis: Elsevier

Campbell F. 2006. Manufacturing Technology for Aerospace Structural Materials

Carus, S. P. (2010). Natural Fibre in Technical Application: Market and Trend. Dalam J. Mussig, *Industrial Application of Natural Fibres* (pg. 78-80). Germany: WILEY A John Wiley and Sons, Ltd,Publication.

Creative Mechanism (2016). Everything You Need To Know About Polypropylene (PP) Plastic. Retrieved from https://www.creativemechanisms.com/blog/all-about-polypropylene-pp-plastic

Ferreira J. A. M., Costa J. D. M., Richardson M. O. W. 1997. Effect of notch and test condition on the fatigue of a glass-fiber-reinforced polypropylene composite. *Composite Science and Technology* 57:1243-1248.

Greco A., Musardo C., Maffezzoli A.2007. Flexural creep behavior of PP matrix woven composite. *Composite Science and Technology* 67: 1148-1158.

H.P.S Abdul Khalil, M. Jawaid, A Hassan, M.T. Paridah and A.Zaidon. 2012. Oil Palm Biomass Fibres and Recent Advancement in Oil Palm Biomass Fibres Based Hybrid Biocomposite.*Composites and Their Application, Chapter 8:*188-220

H Ku, H. W. (t.t). A review on the tensile properties if natural fibre reinforced polymer composite.

HUATEC GROUP CORPORATION, HUATEC Industry Instrumentation. Retrieve from http://www.huatecgroup.com/sale-178555-digital-shore-durometer-for-hardness-test-with-integrated-probe-ht-6600a.html

Isyak Z. A. M., Leong Y. W., Steeg M., J.Karger-Kocsis.2007. Mechanical properties of woven glass fabric reinforced in situ polimerized poly(butylene terepthalate) composites. *Composite Science and Technology* 67:390-398)

K.Vijaya Kumar, Mir S., A.N. Khalel. A. 2013. An Experiment Evaluation of Fiber Reinforced Polypropylene Thermoplastic For Aerospace Application. *Journal of Mechanical Engineering*, vol.ME 43: 92-97

Lauren Fitzpatric. (n.d). Types of Thermoplastic. People of our everyday life. Retrieved from http://peopleof.oureverydaylife.com/types-thermoplastics-6713.html

Layth M, M.N. Ansari., F. Ling. P. (2015). Effect of Chemical Treatment On Oil Palm Fibre/ Epoxy Composite. *International Journal of Science Engineering and Technology,* Vol 3:322-372

Munirah M, A.R. Rahman., A. Hassan. Characterization And Treatments of Pineapple Leaf Fibre Thermoplastic Composite For Construction Application, VOT No: 75147

Mohd Amran, R. I. (t.t). The Effect of Binder on Mechanical Properties of Kenaf Fiber/ Polypropylene Composites using Full factorial Method..

N. Sgriccia, M.C. Hawley, M. Misra. (2008). *Compos.Part A:Appl.Sci.Manufactureing*

Tanja S. (2010). Types of Fiber. Dalam J. Mussig, *Industrial Application of Natural Fibres* (pg. 78-80). Germany: WILEY A John Wiley and Sons, Ltd,Publication.

Trudel-Boucher D., Fisa B., Denault J., Gagnon P. 2006. Experimental investigation of stamp forming of unconsolidated commingled E-glass/polypropylene fabrics. *Composite Science and Technology* 66:555-570

V.Selvakumar, K.Palanikumar,K.Palanivelu. (2010). Studies in Mechanical Characterization of Polypropylene/NA+-MMT Nanocomposites. *Journal of Minerals and Materials Characterization & Engineering*, 671-681.

APPENDICES