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

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Draft Final Report

Final Year Project II

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This report is submitted in fulfillment of the requirement for the degree of Bachelor of Mechanical Engineering (Design and Innovation)

Faculty of Mechanical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

JUNE 2017

DECLARATION

I declare that this project report entitled "Application of Coconut 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 : ....

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 (Design and Innovation).

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

DEDICATION

I dedicate this project to my beloved friends and parents for their endless support.

ABSTRACT

This study investigates the mechanical and physical properties of coconut fiber when reinforced with polypropylene (PP). Coconut or coir fibers were extracted from a bundle of fiber that obtained from the outer layer of the coconut palm. The extraction process was done manually by using cutter. The coconut fibers were treated using sodium hydroxide (NaOH) solution for 2 hours (at room temperature) to reduce surface roughness. Samples of the composite were fabricated with fiber's length of less than 10mm and four loading levels of CFB (10, 20, 30, and 40 wt%). The fabrication of composites was made by using hot press machine model of GT-7014-A until it becomes a thin plate. Physical and mechanical test such as tensile, hardness and density tests were conducted to investigate the effect of increment loading level of CFB in the composite, while the microstructure analysis was conduct to study and analyze the microstructure of the specimen after the tensile test. The experimental results shown that the composite with lowest percentage of CFB which is 10 wt% gave the highest value of tensile strength, tensile strain and maximum load which is 21.3MPa, 0.034 and 1065.24N respectively. Meanwhile, the lowest tensile strength is 17.56MPa which is obtained when the 40 wt% of CFB loading is used in the composite. The hardness and density of the CFB/PP composites showed significantly decreased from 10 wt% to 40 wt% CFB loading. The composite that gave the highest result in hardness test means that it is has high stiffness and able to withstand the given load. Meanwhile, low density means that the composite is not easily to sink when it is immerse in the water. The highest results from hardness test and density test are 67 Shore-D and 1.002 g/cm³ respectively. The results also revealed that alkaline treatment really influences the mechanical properties of CFB/PP composite because alkaline water caused to lower cellulose content on the surface of coconut fibers during surface treatment.

ABSTRAK

Kajian ini dibuat bagi mengkaji sifat-sifat mekanikal dan fizikal serat kelapa apabila diperkuatkan dengan polypropylene (PP). Serat kelapa diekstrak daripada gumpalan sabut kelapa yang diperolehi daripada lapisan luar pokok kelapa. Proses pengekstrakan telah dilakukan secara manual dengan menggunakan pemotong. Serat kelapa telah dirawat dengan menggunakan larutan natrium hidroksida (NaOH) selama 2 jam (pada suhu bilik) untuk mengurangkan kekasaran pada permukaan serat tersebut. Sampel komposit telah dihasilkan dengan menggunakan panjang serat tidak melebihi 10 mm dan empat peratus kandungan berat CFB yang berbeza iaitu 10, 20, 30, dan 40 peratus. Proses penghasilan komposit dibuat dengan menggunakan mesin mampat model GT-7014-A. Ujian fizikal dan mekanikal seperti tegangan, kekerasan dan kepadatan telah dijalankan untuk mengkaji kesan peningkatan kandungan CFB dalam komposit, manakala analisis mikrostruktur dilakukan untuk mengkaji dan menganalisis mikrostruktur spesimen selepas ujian ketegangan. Keputusan eksperimen menunjukkan bahawa komposit yang mempunyai peratusan kandungan CFB terendah iaitu 10% menghasilkan kekuatan tegangan, terikan tegangan dan beban maksimum yang paling tinggi iaitu 21.3MPa, 0,034 dan 1065.24N masing-masing. Sementara itu, kekuatan tegangan yang paling rendah adalah 17.56 MPa yang diperolehi apabila 40% kandungan CFB digunakan dalam komposit. Tahap kekerasan dan ketumpatan CFB/PP komposit menurun disebabkan oleh peningkatan kandungan CFB daripada 10% kepada 40%. Komposit yang memberikan hasil yang paling tinggi dalam ujian kekerasan bermakna ianya mempunyai kekuatan yang tinggi untuk menahan beban yang diberikan. Sementara itu, ketumpatan yang rendah bermakna komposit tidak mudah tenggelam apabila ianya direndam ke dalam air. Keputusan tertinggi daripada ujian kekerasan dan ujian ketumpatan adalah 67 Shore-D dan 1.002g/cm^3 masing-masing. Keputusan eksperimen juga menunjukkan bahawa rawatan alkali telah mempengaruhi sifat-sifat mekanikal CFB/PP komposit kerana penggunaan air alkali semasa rawatan telah mengurangkan kandungan selulos pada permukaan serat kelapa.

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Bismillahirrahmanirrahim,

Alhamdulillah. Thanks to Allah SWT, who with His willing give me the strength and healthy body to complete this Final Year Project with title “Application of Coconut Fiber-PP Composite for Fabrication on Interior Part of Automotive Component”. This final year project report was prepared and submitted in fulfillment of the requirement for the degree of Bachelor of Mechanical Engineering (Design and Innovation).

Firstly, I would like to express my gratitude and deep regard to my supervisor, Dr. Mohd Ahadlin Bin Mohd Daud for guide and assign me a lot of task during two semesters of Final Year Project. I also want to thanks the staff especially assistant engineer from Laboratory of Mechanical Engineering whom which gave me their cooperation, valuable information, suggestions and guidance during preparation the result for my study.

I also would like to thanks and give an appreciation to my parents, family and others for their cooperation, encouragement and constructive suggestions from beginning till the end of the Final Year Project. Also thanks to my friends that have took almost same topic with me for being together in completing all the tasks of our study. Last but not least, deepest thanks to any person which contributes to my final year project directly or indirectly.

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LIST OF ABBREVIATIONS

ABS	Acrylonitrile Butadiene Styrene
ASA	Acrylonitrile Styrene Acrylate
ASTM	American Society for Testing and Materials
CFB	Coconut Fiber
HDPE	High-density Polyethylene
PA	Polyamide
PC	Polycarbonate
PBT	Polybutylene Terephthalate
PP	Polypropylene
PE	Polyethylene
PET	Polybutylene Terephthalate
PMMA	Acrylic
POM	Polyformaldehyde
PUR	Polyurethane
PS	Polystyrene
PVC	Poly-vinyl-chloride
SEM	Scanning Electron Microscopy

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This chapter explains the background, problem statement, objectives and scope of the project. Introduction is the first part of my project report that acquaint with the basic points of the research and the direction of my study.

1.2 BACKGROUND

Natural fibers have recently become more popular as a substitute for synthetic fiber reinforcements in thermoplastic composites such as polypropylene (PP) and polyethylene. Natural fiber can be categorized by two types of fiber which are plant fiber and animal fiber. There are several types of plant fibers for example, as kenaf, jute, sisal, flax, and hemp been increasingly used in the automotive, packaging, construction sport and leisure application (Andrzej K. Bledzki et al, 2010). In order to protect the earth from rapid aging, natural fiber is more suitable to be replaced with synthetic fiber due to their low cost, flexible, better for recycling processes, lightweight, availability, good mechanical properties, high toughness, non-abrasive, environmental friendly and bio-degradability characteristics (Ayrilmis et al, 2011).

Since 1950s, plant fiber have been used in automotive industry for making interior part of automotive component such as seat back, headliners, door panels, package trays, pillar and others (Promper, 2010). Among various types of plant fiber, coconut fibers have durability to withstand heat and it is more resistant to moisture compared to others fibers. Coconut fiber, otherwise known as coir fiber, is a natural fiber extracted as fiber bundles from the husk of coconut. Coconut fiber can be found between the internal shell and the outer coat of a coconut. Before surface treatment, the color of coconut fibers are pale and its wall contained a lot of lignin and cellulose. The purpose of treatment is to clean the surface by removing each impurity (Fior et al, 2015) and to investigate the effect of the treatment when reinforced with polypropylene (O.M.L. Asumani et al, 2012).

Surface treatments are often used to improve the performances of natural fiber reinforced composites by bridging the bonding between the fiber and matrix in composite materials. From previous studies, surface treatment can increase the aspect ratio, which results in better fiber matrix interfacial adhesion (Fior et al, 2015). There are various types of surface treatment to improve the compatibility between lignocellulosic fibers and polymer matrices such as alkali treatment, silane treatment, acetylation, benzoylation, peroxide treatment, permanganate treatment, and isocyanate treatment. Among various types of treatment, alkaline and silane treatment is the most popular solution for surface treatment of fiber. Alkaline treatment involves dipping the fibers in sodium hydroxide (NaOH) while silane treatment soaking the fibers in silanol and alcohol.

Polypropylene is widely used in a lot of application including automotive components such as bumpers, chemical tanks, cable insulation, battery boxes, bottles and petrol cans. It is a semi-crystalline polymer that is used expansively due to its properties, cost and ease to fabricate. Polypropylene is normally tough and flexible, especially when copolymerized with ethylene. Therefore, it is suitable to be used as an interior part of automotive component compared to other plastic such as Acrylonitrile Butadiene Styrene (ABS). When it comes to the use of polypropylene, the temperature of the machine has to be constantly aware during manufacturing process. This is because polypropylene has a tendency to become loamy and harden to be destructed if the machine is overheats.

1.3 PROBLEM STATEMENT

Since the first production automobile was introduced in the last 120 years in Europe, the automobiles have become an important role in the economic development of the country. Due to the increasing of demand and automobile's production, this gave an impact to the health of the natural environment. This is because most of automobile’s manufacturers produce automobile components with synthetic fiber reinforcements in thermoplastic composites such as polypropylene (PP) and polyethylene. Synthetic fibers are often used in various industries, but it is very harmful to be used in automotive application because it cannot withstand heat, malleable and non-biodegradable characteristic.

In order to protect the earth from rapid aging, the natural fibers especially coconut fiber have recently become considerable attention as a substitute for synthetic fiber reinforcements in thermoplastics. An automotive component made from coconut fiber composites contributes for a better life quality due to recycling of the natural ingredient can cause to decrease fuel consumption and gases emission. However, the uses of natural fiber in fabrication of interior part of automotive components are may not necessarily be able to guarantee safety to users. Thus, this study was done to investigate the mechanical and physical properties of coconut fiber when reinforced with polypropylene (PP) composites.

1.4 OBJECTIVES

The objectives of this project are:

1. To investigate the mechanical and physical properties of coconut fiber reinforced with polypropylene (PP) as a matrix with varying fiber weight fraction.
2. To observe the microstructure of coconut fiber reinforced polypropylene composite by using Scanning Electron Microscopy (SEM).

1.5 SCOPE

This project focuses on the effect of coconut fiber when reinforced with polypropylene (PP) as well as on their physical and mechanical properties. This project involve with two (3) types of test which are mechanical test, physical test and microstructure analysis. In physical test, each sample must undergoes density test (ASTM D792) and hardness test (ASTM D2240). For mechanical test, they must undergo only tensile test (ASTM D3039/D3039M). Coconut fiber must treat with alkaline water and chop into length of less than 10 mm. Before it is going to be tested, the polypropylene must crush and blend until it becomes delicate powder. Then, four loading levels of the coconut fiber content of 10, 20, 30, and 40 percent are separate based on the composition by weight percentage and mix with the PP powder to compress until it becomes a thin plate.

CHAPTER 2

LITERATURE REVIEW

2.1 COCONUT FIBER

Coconut or coir fibers are extracted from fiber bundles that obtained from the outer layer of the coconut palm. The name ‘coir’ for coconut fiber is obtained from the Tamil and Malayalam word ‘Kavur’, which means rope. A single coir fiber has a coarse surface with mean width of 0.02 mm and a mean length of 2.5 mm. Coconut fiber has the highest lignin content compared to other fiber such as flax, hemp and wool (Jayasekara & Amarasinghe, 2010). The advantages of coconut fiber are that it is non-abrasive, porous, stiff, resilient, hydroscopic, viscoelastic, biodegradable, compostable and combustible (Ali, 2011). As a fiber, it has a high strength, low in energy conversation and has good insulation properties.

In the past, coconut fiber has been considered as a low quality. The quality of the coconut fiber depends on the extraction process. Normally, many people extract the coconut fiber by using traditional process. Traditional extraction process of coconut fiber involves harvesting and husking, retting, difebering and finishing process (Kavitha, n.d). In generally, the fiber was extracted from the husk that have been soaked for 6-9 month in a sea water or lagoon water, and then beaten with a wooden mallet. The retting process can soften and reduce the lignin of fiber. Sustainable methods in production of fibers have potential to produce constant quality of fibers. Biotechnological approach with specific microbial enzymes and shorten the retting time method can activate the fiber surface to react more easily with dyes.

2.1.1 Structure of Coconut Fiber

Coconut fibers are found between the skin and inner shell of a coconut. Every single of fiber cells has a narrow, thick wall that consists of cellulose. Each cell has 1 mm long and 10 to 20 µm in diameter. The coconut fiber bundles have varies size depends on the place in which it is grown and also with the environment condition. According to Schnegelsberg (1999), coir fibers bundles can be divided into white coir, brown coir, bristle, omat, mattress and mixed. The immature's fiber is white color, but once it grown it will become brown as a layer of lignin is deposited on their walls. By comparing between both types of fibers, fiber with brown color is stronger, thick and has high abrasion resistance. Both fibers are typically consists of 0.1 to 0.3 mm length. The fiber that contain more lignin and cellulose is more stronger because cellulose consist of thousands glucose unit that can stack to form crystalline with intramolecular hydrogen bonds providing a stable, hydrophobic polymer with high tensile strength (Akin, 2010). The Figure 2.1 below shows the molecule structure of crystalline cellulose.

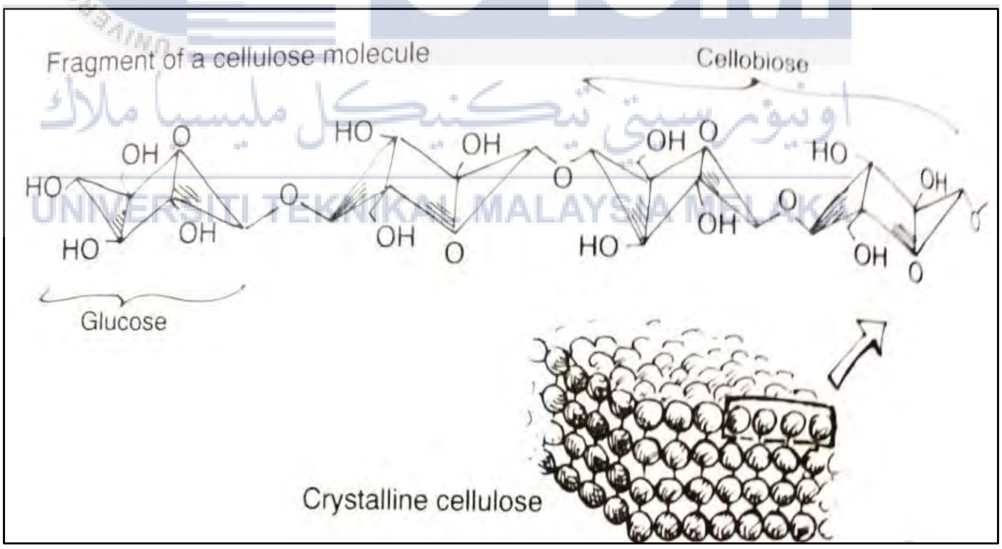


Figure 2.1: The molecule structure of crystalline cellulose

2.1.2 Chemical Properties of Coconut Fiber

The main chemical components of coconut fiber bundles are cellulose, hemicellulose and lignin (Ali, 2011). These three types of composition can affect the properties of coconut fiber. Most of plant fibers consists more than 70% of cellulose. Cellulose is an inactive metabolism of structural carbohydrate and polysaccharide that consists of a linear chain of $C_6H_{10}O_5$. Hemicelluloses occur mainly in the primary cell wall and have contains many different sugar monomers with varied chemical structure. The combination of cellulose and hemicellulose is known as holocellulose. Lignin is a polymer of phenylpropanoid units and has an aromatic structure. Lignin is formed from three different phenyl propane alcohols known as coumaryl alcohol, coniferyl alcohol and sinapyl alcohol. Lignin in the cell walls provides stiffness and color. It is also able to decrease absorption of water across the cell walls. Lignin also plays as important roles in the transport of water, nutrients and metabolites in the vascular system of plants. Furthermore, lignin in plant cells helps to maintain stiffness of the cell wall and provides obstacle towards compression and bending, as well as a protection against attack by microorganisms. The lignin and hemicellulose provides the adhesive to increase the bonding of molecule structure of the fiber.

2.1.3 Applications of Coconut Fiber

Production based on coconut fiber have developed in many countries especially in India, Tanzania, Kenya, Bangladesh, Burma, Thailand, Sri Lanka, Nigeria, Ghana and Malaysia. The coconut fibers are widely used in making spinning of yarns, ropes, doormats, mattings, mattings, carpets, rugs, brushes and others (M. Kavita, 2015). In three decades ago, the application of coconut fiber has expanded extensively for the manufacture of interior part of automobile. This is because the coconut fibers have possibility to decrease weight and cause to better crash absorbance and sound insulation when applied to door trims, instrument panels, package trays, glove boxes, arm rests and seat backs (Szeteiova, n.d.). Apart from that, the coconut fiber also been used as a material in the fabrication of furniture, cabinets, boxes and vases and others (Ali, 2011). It also can be used to replace construction materials such as tiles, bricks, plywood, and asbestos and cement hollow blocks. In other engineering technology, coconut fibers are suitable to be used in composites for different purposes such as reinforcement of natural fiber and polymer as a substitute material.

2.2 POLYPROPYLENE (PP) COMPOSITE

Polypropylene (PP) is a semi-crystalline polymer that is widely used in a lot of application due to its unique combination of properties, cost and ease to fabricate (Sakthivel et al, 2014). All polypropylene have grades that consist of polymer, a neutralizer and antioxidants. Other additives like clarifiers, nucleates, slip additives, UV stabilizers, silica, talc, and calcium carbonate are added to resins to protect the polymer during fabrication process and to enhance better performance. The polymer might be a pure homopolymer made from polymerizing propylene while a random copolymer made from propylene and another monomer such as ethylene or an impact copolymer is made from dispersing rubber in polypropylene matrix. Polypropylene can be fabricated in various types of method like film/sheet extrusion, non-wovens, multifilament, injection molding, blow molding and profile extrusion.

In 1954, the first polypropylene was polymerized by Professor Giulio Nattain in Spain. Production of polypropylene expanded in a lot of application such as textiles, stationery, food container, automotive part and others. In 2013, the global market for polypropylene was spread about 55 million tonnes. Polypropylene is almost used to fabricate in all car's component such as bumpers, doors, windows, headlight and side view mirror, trunk lids, hoods, grilles and wheel covers. Based on the Table 2.1 below, 32 percent out of total plastic used in car is polypropylene (Katarina, n.d). Production of polypropylene takes place by gas phase process in which involves exposing the propylene monomer to heat and pressure in the presence of a catalyst system. Polymerization is achieved at relatively low temperature and pressure and the product produced is translucent and ready in colored. Differences in catalyst and production conditions can be used to change the properties of the plastic.

Table 2.1: Main types of plastic used in Automotive

Component	**Main Types of Plastic**
Bumpers	PS, ABS, PC/PBT
Seating	PUR, PP, PVC, ABS, PA
Dashboard	PP, ABS, SMA, PPE, PC
Fuel systems	HDPE, POM, PA, PP, PBT
Body (incl. panels)	PP, PPE, UP
Under-bonnet components	PA, PP, PBT
Interior trim	PP, ABS, PET, POM, PVC
Electrical components	PP, PE, PBT, PA, PVC
Exterior trim	ABS, PA, PBT, POM, ASA, PP
Lighting	PC, PBT, ABS, PMMA, UP
Upholstery	PVC, PUR, PP, PE
Liquid reservoirs	PP, PE, PA

The properties of polypropylene include semi-rigid, translucent, good chemical resistance, tough, integral hinge property, good fatigue resistance and heat resistance (Mazumdar, 2002). Based on the Table 2.2, it has lowest density which is 0.9 g/cm^3 than other types of thermoplastic. It also stands to present stress-cracking problem and has good electrical and chemical resistance at high temperature. However, polypropylene is poor UV resistance and has high mold shrinkage and thermal expansion which easy to shrink and become loamy if it is overheat. All the forming process of polypropylene can be formed by sheet extrusion. The melting point of polypropylene is performed at temperature among 160℃ to 180℃. Under these conditions, the sheet is relatively strong and able to avoid shrink. A small change in temperature resulted in large change in forming force. This type of technique can be used to process all grade of polypropylene. The Table 2.2 below shows typical properties of thermoplastic.

Table 2.2: Typical properties of thermoplastic

Materials	**Density (g/cm^3)**	**Tensile Modulus [Gpa (10^6 psi)]**	**Tensile Strength [Mpa (10^3 psi)]**
Nylon	1.1	1.3-3.5(0.2-0.5)	55-90(8-13)
PPS	1.3-1.4	3.4(0.49)	80(11.6)
Polyester	1.3-1.4	2.1-2.8(0.3-0.4)	55-60(8-8.67)
Polycarbonate	2	2.1-3.5(0.3-0.5)	55-70(8-10)
Polyethylene	0.9-1.0	0.7-1.4(0.1-0.2)	20-23(2.9-5)
Acetal	1.4	3.5(0.5)	70(10)
Polypropylene	0.9	1.4	23

The major end users of polypropylene are the packaging industry. Polypropylene has a relatively slippery surface which possible to be used in variety application such as in household and industrial application. The polypropylene is not useful in heavy applications such as door, and turbomachinery. However, it is useful for non-load-bearing applications such as the cover on a bottle of ketchup or shampoo. Polypropylene also can be used to manufacture living hinges because it is high impact (Mazumdar, 2002) and does not break if repeatedly bent. Rather than use other prototyping, one of the advantages is that polypropylene can be manufacture by using CNC machine which allow for faster the process development of product.

2.3 COCONUT FIBER REINFORCED POLYPROPYLENE (PP) COMPOSITE

The use of polymer becomes increasingly combined with various reinforce in order to improve the mechanical properties of material. The synthetic polymer been replaced with fiber to increase the strength as well as decrease the weight, cost and pollution of environment (Haque et al, 2016). Recently, coconut fibers was used as the reinforce material since it is has a least effect to the environment because of its biodegradable properties. The aim of these composites is to create sustainable materials that maintain a better life quality for future. Coconut fiber reinforced composites have found commercial application in the construction and automotive industries. These composite are used as a material in fabrication of interior part of automotive such as dashboards, door panels, parcel shelves, seat cushions, backrests and cabin linings (Ayrilmis et al, 2011).

Coconut fiber reinforced polypropylene has been study by other researcher on their possibility to improve the behavior of a material used in the engineering technology. The result show that the bonding strength between coconut fiber and polypropylene contributes towards better behavior of the ensuing composites (Sakthivel et al, 2014). The behavior of the composites changes significantly by increase the level content of coconut fiber (Haque et al, 2016). The thermoplastic reinforced with the coconut fiber had a greater dimensional stability compared to other reinforcement of natural fibers. This is because the coconut fiber has lowest cellulose and hemicellulose contents that can provide stiffness (Ayrilmis et al, 2011). This observation showed that the increasing level content of coconut fibers significantly improved the stiffness of the samples.

2.4 SURFACE TREATMENT

Natural fibers have potential to improve the mechanical properties when reinforced with thermoplastic composites (O.M.L. Asumani et al, 2012). However, the natural fibers also have limitation in chemical modification due to chemical incompatibility between the hydrophilic lignocellulosic molecules of the natural fiber and the hydrophobic thermoplastic molecules can cause to unproductive load transfer between the reinforcing material and matrix. There are various types of treatment that can be used to improve the compatibility between lignocellulose fibers and matrix such as alkaline treatment, silane treatment, acetylation, benzoylation, peroxide treatment and others. Among these types of treatment, the most widely being used are alkaline and silane treatments.

2.4.1 Alkaline Treatment

Alkaline treatment involves soaking the fibers in sodium hydroxide for period of time. Sodium hydroxide commonly used in the chemical pretreatment of lignocelluloses because of its ability to dignify biomass (Sindhu et al, 2014). Alkaline treatment also has potential to changes the alignment of crystalline cellulose structures and forms an amorphous structure by swelling the wall of fiber cell. From the previous research, they believed that the surface roughness of the fiber can be removed by doing alkaline treatment (Sindhu et al , 2014) because it can expose more cellulose on the surface of the fiber wall that can increase the chemical bonding with the matrix material. They also have reported that treat fiber increase 30% in tensile strength and modulus of flax reinforced epoxy composite (Fiore, 2015). According Vinay (2013), the alkali-treated coir fiber–polyester composites with a volume fraction ranging from 10% to 30%, resulting better properties than composites manufactured with untreated fibers, but the flexural strength (FS) of these composites was consistently lower than the bare matrix.

2.4.2 Silane Treatment

Silane treatment usually involves immersing the fibers in solution of a silane dissolved in a water or alcohol and/or alcohol mixture. The use of silane solution is to form a stable covalent bond to the cell wall (Asumani et al, 2012). It is also can improves the degree of cross-linking in the interface region, allowing it to form a strong bonding between the fiber and matrix. From the previous study, the treated fiber using silane solution increased approximately 45% tensile strength compared to untreated fibers. The loading level of silane is function as filler to the surface area of the fibers. Typically, the average size of filler with range of 1 to 5 microns gives best result when treated with 1% silane. It was found that the increasing of strength and stiffness of the composite can be improved with only a small concentration of silane.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter describes about the methodology used in this project to obtain the information and achieve the objectives of this study. The methodology of this study was summarized in the flow chart as shown in Figure 3.1 below. Based on that Figure 3.1 below, this project start by studying the theory related with the topic. The internet article and journal been selected from various website in order to seek the information. Then, the materials have been prepared before it going to be compressed and tested during an experiment. From the experiments, the result will be analyzed to identify the improvement of the physical and mechanical properties for each sample. The graph will be shown to compare the analysis of each sample. If the result is not fully satisfied, this project can be continue with discussion on the problem that caused to failure in the report writing without need to repeat the experiment.

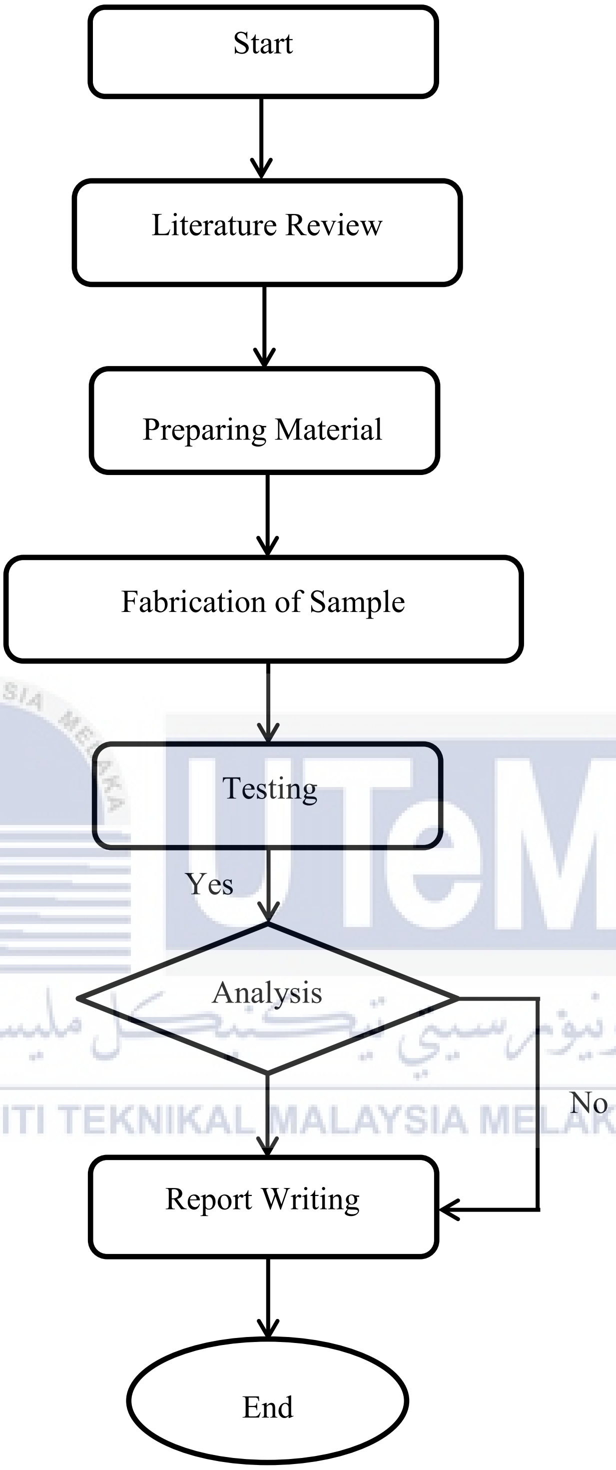


Figure 3.1: Flow chart of the methodology

3.2 PREPARATION OF RAW MATERIALS

The raw materials used in this project are coconut fiber and polypropylene. The polypropylene was given by the supervisor in form of pellets. A bundle of coconut or coir fibers were extracted from the husks surrounding the seed of coconut and weighed more than 32 grams. The extraction process was done manually by using chopper. After the separation of fiber from the husk, the coconut fibers were dried under sunlight for one week. Six percent out of 1000 grams of sodium hydroxide were solvent in 12 litres of distilled water to make sodium hydroxide (NaOH) solution. Then, the coconut fibers were dipped in sodium hydroxide (NaOH) solution for 2 hours at room temperature to reduce surface roughness. The fibers were washed several times with distilled water and tab water to remove the excess of sodium hydroxide (NaOH). Finally, the coconut fibers were dried under sunlight until it fully dried. After that, the treat coconut fibers were chopped into length of less than 10mm each before it going to mix with polypropylene powder. The following below shows the process involve in preparing material of coconut fiber:

Figure 3.2: The process of preparing the coconut fiber

For the preparation of polypropylene powder, the polypropylene must be placed in the grinding bowl and crushed using a grinding machine until it becomes coarse powder. The grinding machine is known as High Manganese Grinding Bowl (GM/F2000-1). High Manganese Grinding Bowl can be used only less than 20 grams of polypropylene for every 1000 seconds, if more than that the polypropylene will become flakes. Then, coarse powder was blended several times using a blender to get a delicate powder. Finally, the powder was sieved to get a consistent size of powder. The Figure 3.2 below show the process involved in preparing the polypropylene powder.

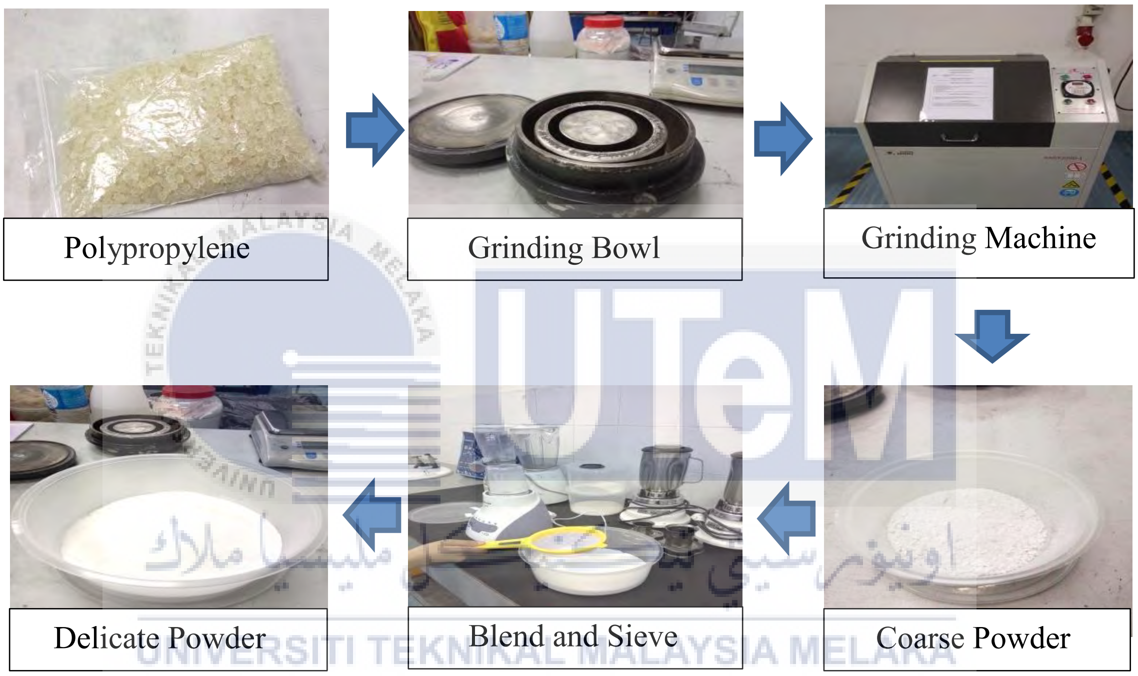


Figure 3.3: The process of preparing the polypropylene powder

3.3 FABRICATION OF SAMPLES

The treat coconut fibers were separate into four loading levels of the content which are 10, 20, 30, and 40 % based on the ratio by weight percentage between fiber and polypropylene composites. Then, each contents of treat coconut fiber were mixed with PP powder to prepare the sample. The mixture of both materials was placed in the mold and compressed by using hot press machine model of GT-7014-A until it becomes a thin plate. Before that, the temperature used to compress the mold was set to be 170°C. Then, the mold was placed inside hot press machine to preheat the mixture of CFB/PP for 5 minutes. After that, the mold was compressed with pressure of 25kg/$cm^2$for another 5 minutes. After compression process, the mold was cooling for 20 minutes to produce a sample in form of solid. Next, the sample was taken out from the mold using a “H” type hydraulic press machine. The process was repeated for four times with different weight percentage of fiber and polypropylene. Finally, each sample has been cut with dimension of $140mm \times 25mm \times 3mm$ for mechanical and physical test. The Figure 3.4 below shows the fabrication process of composites.

Figure 3.4: The fabrication process of composites

From the Table 3.1, it is shows the samples of CFB/PP composite after hot compression for each composition.

Table 3.1: The composition of CFB/PP composite

SAMPLE	CFB/PP LOADING (wt%)	CFB/PP LOADING (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

3.4 EXPERIMENT

Each sample involved with three types of test which are mechanical test, physical test and microstructure analysis. For physical test, all samples have go through density test, hardness test and microstructure analysis while in mechanical test, they have go through only for tensile test. The microstructure analysis of sample will be analyzed by using Scanning Electron Microscopy (SEM). All the process involved during testing the samples have been conducted at the laboratory.

3.4.1 Tensile Test

The tensile test was prepared according to the ASTM D3039/D3039M standard. The specimen with dimensions of 140 mm length, 25 mm width and 2 mm thickness were tested using an Instron Universal Testing Machine (model of 5585H). During tensile test, the machine was set to be operated at constant head-speed tests of 2 min/mm. The specimen was grip at both end of the specimen and load was applied hydraulically until it begins to stretch and finally breaks. Then, the values of maximum load, extension, tensile stress, tensile strain (extension) were recorded and shown in the computer that support by Bluehill software. The experiment was repeated by testing the different composition of CFB/PP composites. The Figure 3.4 shows an Instron Universal Testing Machine used for tensile test.

Figure 3.5: An Intron Universal Testing Machine

3.4.2 Density Test

The procedure of density test has been conducted by followed the ASTM D792 standard. The ASTM D792 standard has two types of method which are Method A and Method B. The most commonly being used is Method A which used to test solid plastic in water. For apparatus, the water shall be substantially air-free and distilled or de-mineralized water and the test specimen shall be a single piece of material with a thickness not less than 1 mm per grams. By using an electronic densimeter (MD-300S) as shown in Figure 3.5, the specimen was immersed in the water with plastic sinker that is lighter than water. Then, the specific gravity and volume of the specimen were recorded and the procedures were repeated for the required number of specimens. Lastly, the density of specimens was determined by calculate using this following formula:

$$\textbf{Density, } \rho_{specimen} \ (\mathrm{g}/cm^3) = \textbf{specific gravity x 1 g}/cm^3$$

Figure 3.6: An electronic densimeter

3.4.3 Hardness Test

Hardness test has been conducted by followed the ASTM D2240 standard using Durometer Hardness method to measure the hardness of CFB/PP composites. This method has been done manually using an analogue Shore scale "D" type of Durometer as shown in Figure 3.6. The testing was started by placing the specimen on a flat surface. Then, the indentor of the durometer gauge was pressed into the specimen as shown in Figure 3.7 to measure the hardness of the specimen. The hardness value was read within one second of firm contact with the specimen. The procedures were repeated for three times for each sample to get the accurate values.

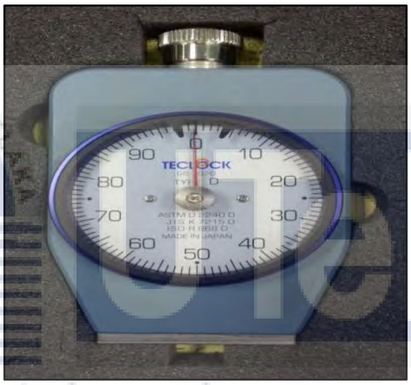


Figure 3.7: An analogue Shore scale "D" type of Durometer

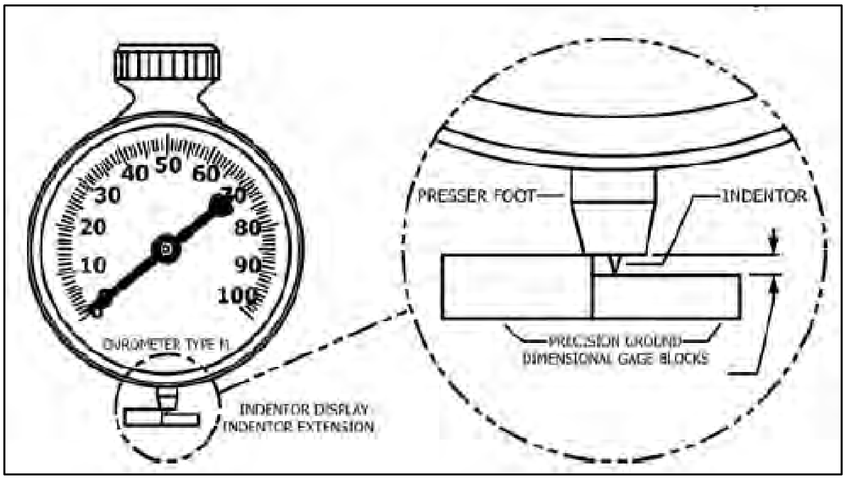


Figure 3.8: Detail of Indentor Extension and Display Adjustment

3.4.4 Microstructure Analysis

Microstructure analysis was conducted to study and analyze the microstructure of the specimen after the tensile test. The composite was cut into small piece of specimen with area of 1cm×1cm. Then, it was rubbed with sand paper to remove dirt or rough surface. Each specimen was mounted in vertical orientation on the stubs. Then, they were air-dried and coated with a thick platinum inside an auto fine coater (model of JEC-3000FC) as shown in Figure 3.8. During microscope examination or microstructure analysis, the Scanning Electron Microscope (model of JEOL JSM-6010PLUS/LV) was used to observe the internal structure of fracture surface of the specimen due to tensile test and the interfacial bonding of CFB/PP composite. In Scanning Electron Microscope (SEM), the specimen under vacuum was scanned by a beam of electron, which generates several reactions to focus and form a high resolution images. The Figure 3.9 shows the Scanning Electron Microscope (SEM).

Figure 3.9: An auto fine coater

Figure 3.10: The Scanning Electron Microscope

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

This chapter explains about the results and discussion on the mechanical and physical properties of coconut fiber when reinforced with polypropylene (PP). These all results were obtained from the tensile test, hardness test, density test and microstructure analysis.

4.2 MECHANICAL PROPERTIES OF COMPOSITES

Based on the Figure 4.1, sample with lowest CFB loading was give the highest value of tensile strength which is 21.3 MPa. However, there is reduction in tensile strength when the weight percentage of coconut fibers increased from 10 to 40 percent in the composite. The lowest tensile strength is 17.56 MPa which is obtained when the 40 percent of CFB loading is used. The results show that the increasing content of coconut fibers influenced the mechanical properties of composites. Since the orientation of fiber was array in random orientation, the interfacial bonding between the fiber and the polymer matrix is not well bonded and the mobility of the molecular chains at the interface increase, which leads to lower the stiffness of the composite.

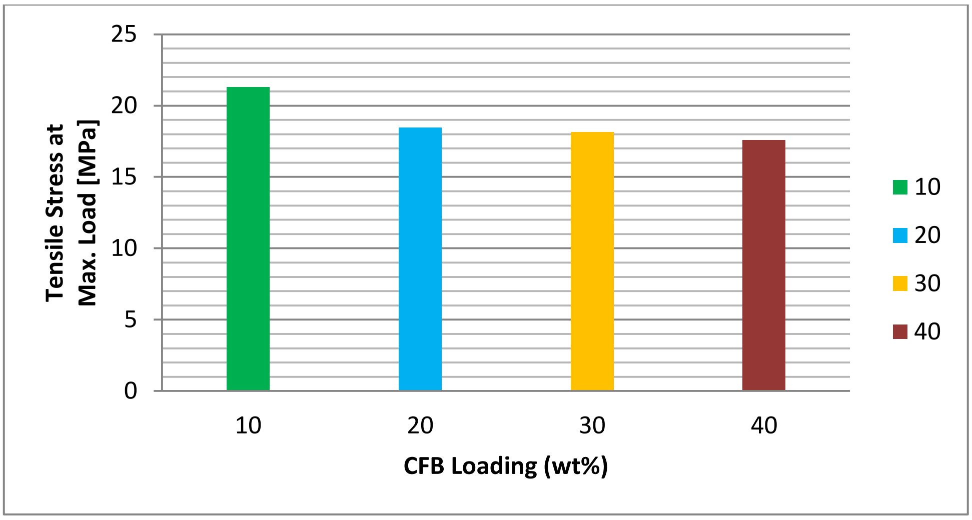


Figure 4.1: The tensile stress against weight percentage of coconut fiber

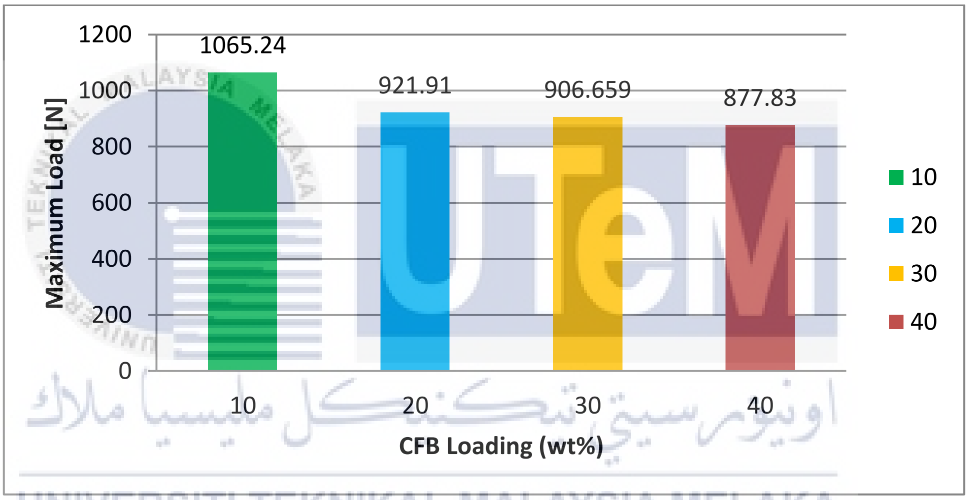


Figure 4.2: The maximum load against weight percentage of coconut fiber

The maximum load also depends on the weight percentage of the coconut fiber in the composite. According to Figure 4.2 above, it is shows that the value of maximum load was influenced by the content of coconut fibers in the composite. The value of maximum load for each sample change as their content of coconut fibers increased from 10 to 40 percent. Among four loading levels content of the coconut fiber, the composite or sample with 10 percent of CFB reached the highest value of maximum load which is 1065.24N, while the composite with 40 percent of CFB reached the lowest value of maximum load which is 877.83N. It means that the lower loading levels content of the coconut fiber, the stronger it can withstand the given load. This is because PP is a thermoplastic, so it is originally stronger without coconut fiber.

According to Figure 4.3 below, the graph shows the load against extension. The trend of the graph indicates that the extension of the composite is directly proportional to the load. The extensions of composites are declined gradually by increasing the content of fiber in the composite. Based on the Figure 4.3, the sample that has lowest composition of CFB/PP composite which is Sample A has high strength compared to other samples. This is because Sample A is able to extended more than 4mm with maximum load of 1065.24N which is the highest load among composite. The highest maximum load means that the composite has more potential to withstand the given load. The lowest strength of composite is Sample D which is extended up to 2mm with maximum load of 877.83N. The extension of composites increased when the load of each composite increased. It can be related with the increasing content of polypropylene in the composite because polypropylene is originally tough and have high tensile strain and tensile stress compared to coconut fiber.

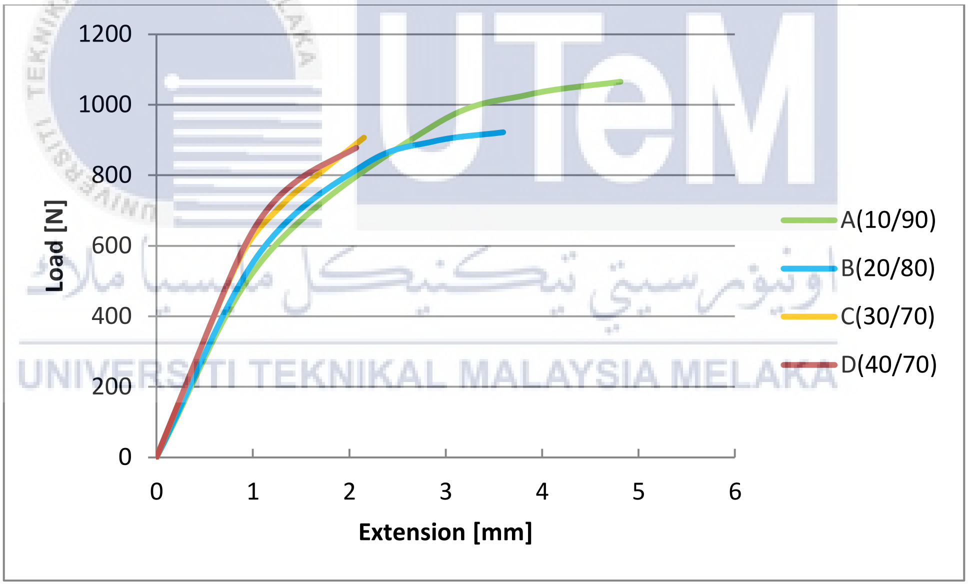


Figure 4.3: Graph of load against extension

Stress–strain curve was plotted as shown in Figure 4.4 to determine the relationship between tensile strength and tensile strain of composites. The trend of graph shows that the tensile stress is directly proportional to the tensile strain. It means that the tensile stress increased when the tensile strain increased. Based on the graph in Figure 4.4, Sample A was achieved the highest result in tensile stress and tensile strain which is 21.3MPa and 0.034 respectively. Meanwhile, Sample D was achieved the lowest result in tensile stress and tensile strain which is 17.56MPa and 0.016 respectively. By comparing these all result, the sample that has lowest content of coconut fiber which is Sample A is tougher than the other samples. The samples that have high content of fiber affected to decreased the tensile stress and tensile strain due to lower cellulose content on the surface of coconut fibers during surface treatment. The cellulose is function to form the alignment of crystalline with intramolecular hydrogen bonds and generate a stable structure to improve the tensile strength of the composites (Akin, 2010).

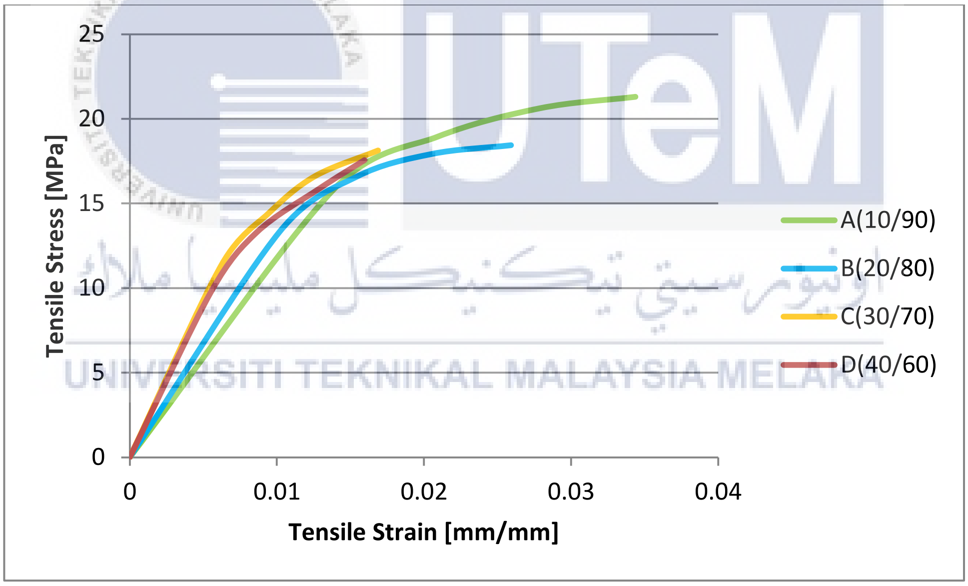


Figure 4.4: The tensile stress against tensile strain

4.3 PHYSICAL PROPERTIES OF COMPOSITES

The results shown in the Table 4.1 below is the physical properties of composites. The result shows that the hardness and density of composites significantly decreased with increment content of the coconut fiber in the composite. Among four samples, Sample A gave the highest result in density test because it has the highest content of coconut fiber compared to other samples. The sample that has lowest density is Sample D, which is not easily to sink when it is immerse in the water. The decrement of density is because coconut fiber has layer of lignin and cellulose to act as shelter to prevent the composite from easily to absorb water. According to the Table 4.1, Sample A is not only gave the highest result in density test but also in hardness test. The composite that gave the highest result in hardness test means that it is has high stiffness and able to withstand the given load. This is because coconut fiber has high stiffness in the cell wall and provides obstacle towards compression and bending.

Table 4.1: The Physical properties of composites

Sample Composite	**CFB Loading, (wt%)**	**Durometer Hardness**	**Density, ρ (g/cm^3)**
A	10	67	1.002
B	20	66	0.996
C	30	65.5	0.995
D	40	65	0.994

4.4 MICROSTRUCTURE ANALYSIS

Based on the Figure 4.5 below, the results from the microstructure analysis revealed that all samples have different percentage of coconut fiber in the composite. The Figure 4.4 shows that there is increment percentage of fiber from Sample A to Sample D. By comparing all samples, Sample D has highest percentage of CFB in the composite while Sample A has lowest percentage of CFB in the composite. The other two sample which are Sample B and Sample C still have high percentage of CFB if compared to Sample A, but their percentage of CFB are low if compared with Sample D.

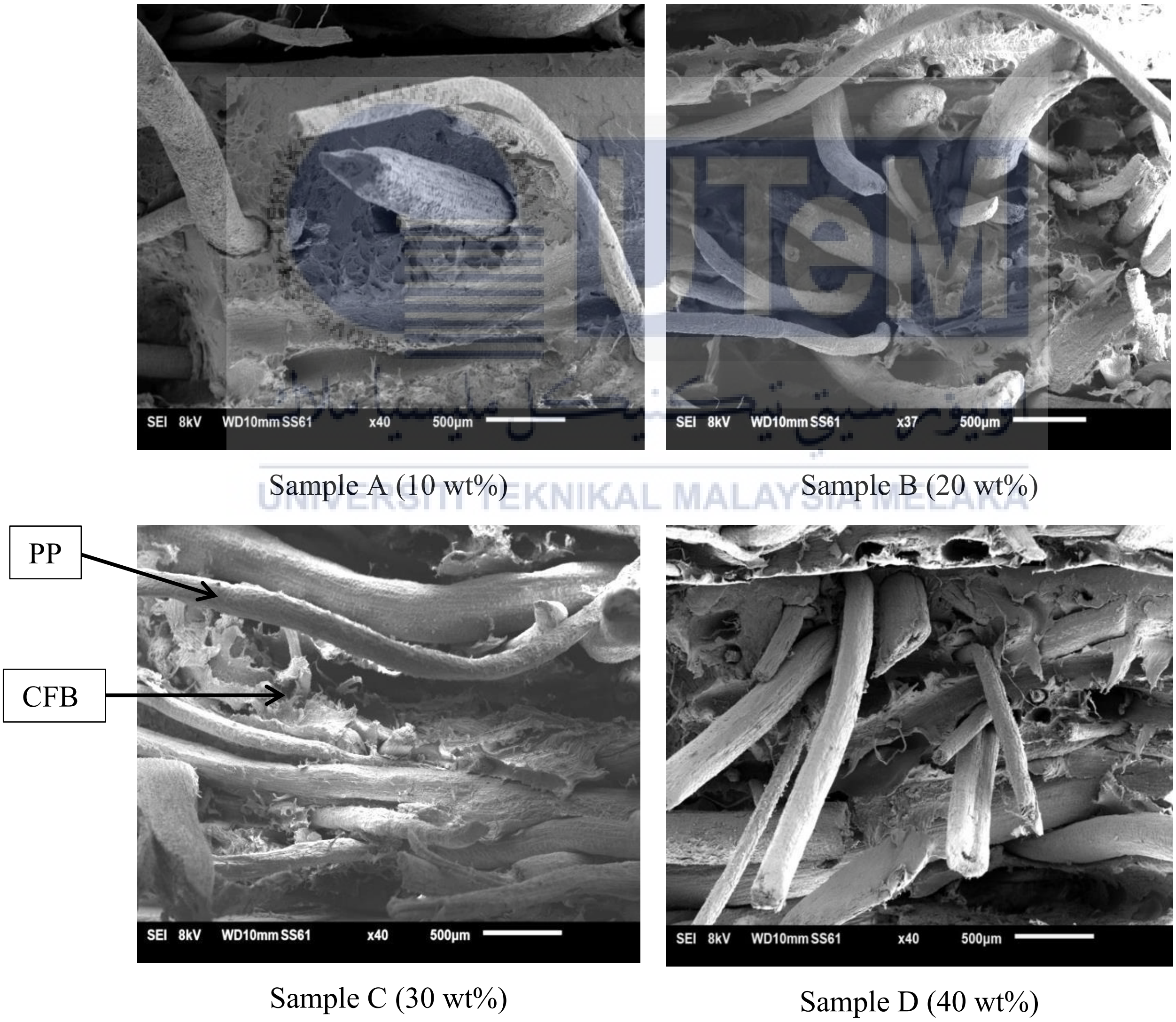
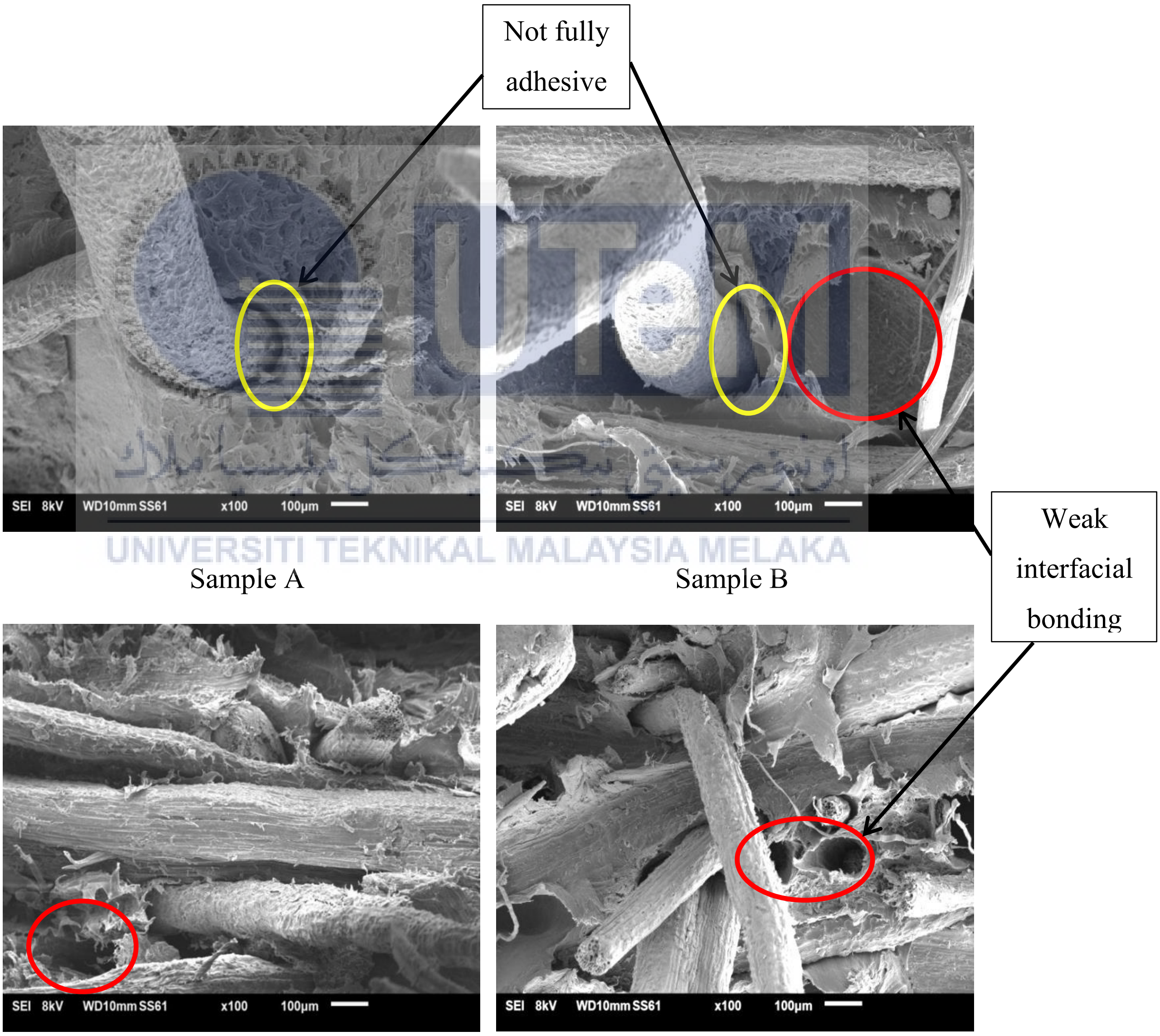


Figure 4.5: The percentage of fiber in the composite

According to Figure 4.6 below, it is shows the bonding between coconut fiber and polymer matrix. The results show that the coconut fibers seemed not fully adhesive with polymer matrix because there is gap between their bonding. Based on the observation, some of the coconut fiber in Sample B, Sample C and Sample D are easily to pull off from their bonding with polymer matrix. The coconut fibers are easy to pull off from their bonding due to weak interfacial bonding between the fiber and the polymer. The adhesion bonding between CFB and polymer matrix also tend to weak due to higher fiber content in composites.



Sample C

Sample D

Figure 4.6: The bonding between coconut fiber and polymer matrix

The Figure 4.7 shows the detail microstructure of composites after the tensile test. The result from the Scanning Electron Microscopic (SEM) shows that the coconut fibers are randomly orientated and it is not perfectly aligned with polymer matrix. There are different sizes of fiber in each composite. The surface of fiber is smooth after been treated with alkaline water for 2 hours. From the Figure 4.6, the microstructure of Sample C and D show that they have the most broken fibers compared to other samples. This is because the increasing content of CFB leads to weaken the strength of composite and decrease the physical and mechanical of composites.

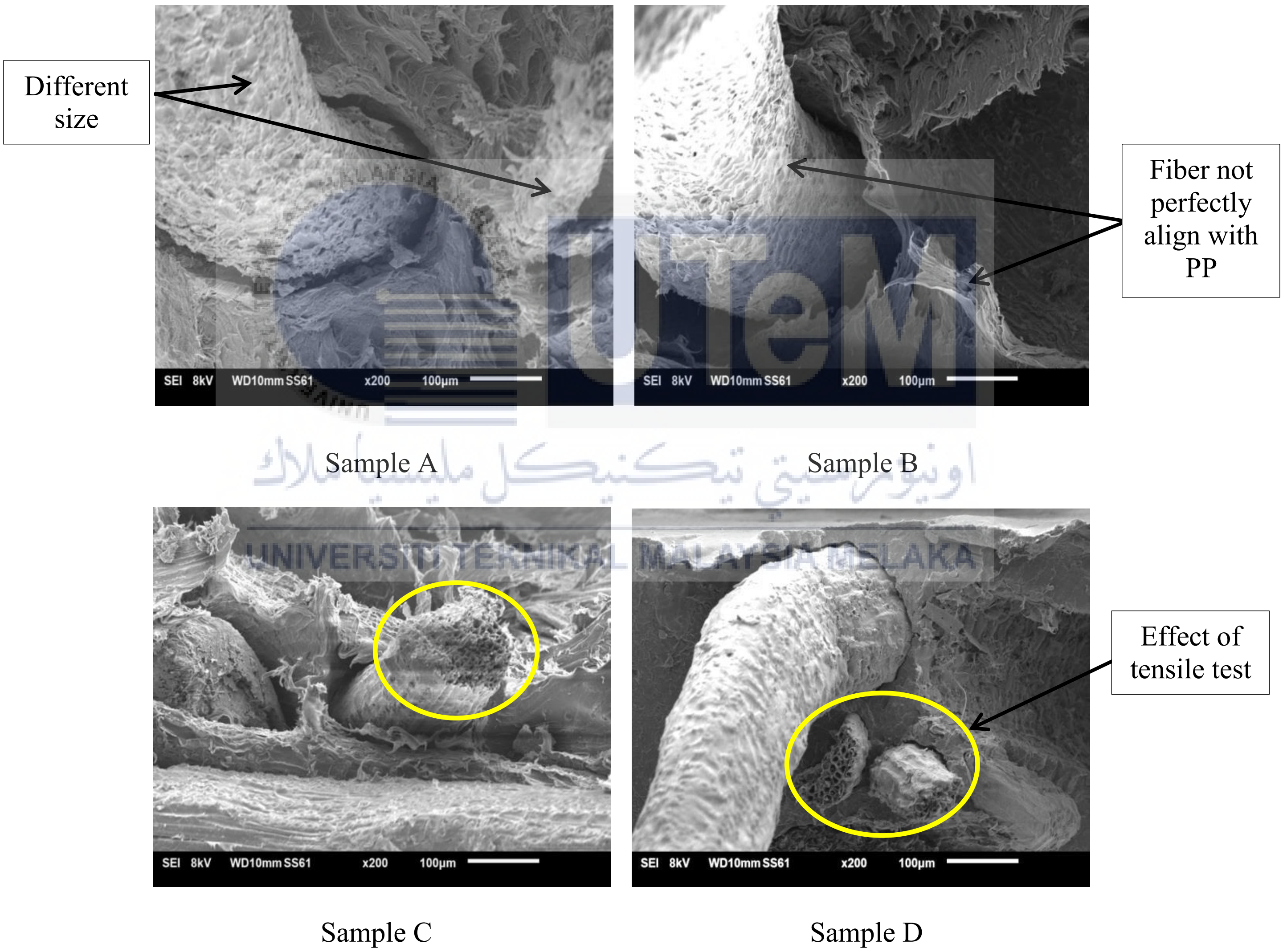


Figure 4.7: The detail microstructure of composites

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

This chapter explains about the conclusion and recommendations of the study about an "Application of Coconut Fiber-PP Composite for Fabrication on Interior Part of Automotive Component".

5.2 CONCLUSION

The objectives of this study has been achieved by investigate the mechanical and physical properties of coconut fiber reinforced with polypropylene (PP) as a matrix with varying fiber weight fraction. The experimental data shown that the CFB/PP composite with lowest percentage of CFB which is 10 wt% gave the highest result in tensile strength, tensile strain and maximum load which is 21.3MPa, 0.034 and 1065.24N respectively. Meanwhile, the lowest tensile strength is 17.56 MPa which is obtained when the percentage of CFB increased from 10 wt% to 40 wt% in the composite. The sample that has highest percentage of coconut fibers which is 40wt% gave the lowest result in density test and hardness test with value of 65 Shore-D and 0.994 g/cm^3 respectively. High in hardness test means that it is has high stiffness and able to withstand the given load while low density means that the composite is not easily to absorb water. Therefore, all results can be conclude that the reinforcement between CFB/PP composite have influenced the mechanical and physical properties of composites.

5.2 RECOMMENDATION

For future study, the procedures for preparation of materials can be improved by consider the aspect of fiber orientation. The orientations of coconut fibers should be arranged in parallel orientation so that CFB/PP composite well bonded during hot compression. Besides, the soaking time during alkaline treatment of coconut fiber should not be too long because alkaline water can strongly damage the surface of fiber, thus resulting to lower the tensile strength of composites. In addition, the composite should be fabricate with different length of fiber in order to investigate which length give the best result in mechanical and physical properties. The result from the experiment also can be improved by adding more weight percentage of coconut fiber which is from 10 wt% to 60 wt%. During fabrication process, the mold should be clean before place the mixture of coconut fiber and polypropylene powder inside it. The mold could not be cleaned using tab water because it can lead to rust, thus effect the tensile strength of composites. The storage container containing of PP powder must be closed tightly when not in use to prevent other materials in and mixed with it.

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APPENDICES