

ON THE USE OF NANO FIBRILLATED CELLULOSE (NFC)
FIBER AS REINFORCEMENT IN POLYLACTIC ACID (PLA)
MATRIX COMPOSITES

CARRON TING SHUANG SIA
B051410115

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
2018



**ON THE USE OF NANO FIBRILLATED CELLULOSE (NFC) FIBER
AS REINFORCEMENT IN POLYLACTIC ACID (PLA) MATRIX
COMPOSITES**

Submitted in accordance with requirement of the University Teknikal Malaysia Melaka (UTeM)
for Bachelor Degree of Manufacturing Engineering (Hons.)

by

CARRON TING SHUANG SIA

B051410115

940331-13-5648

FACULTY OF MANUFACTURING ENGINEERING

2018

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: **ON THE USE OF NANO FIBRILLATED CELLULOSE (NFC) FIBER AS REINFORCEMENT POLYLACTIC ACID (PLA) MATRIX COMPOSITES**

Sesi Pengajian: **2017/2018 Semester 2**

Saya **CARRON TING SHUANG SIA (B051410115)**

mengaku membenarkan Laporan Projek Sarjana Muda (PSM) ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. *Sila tandakan (√)

SULIT (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysiasebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)

TERHAD (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/ badan di mana penyelidikan dijalankan)

TIDAK TERHAD

Disahkan oleh:

Alamat Tetap:

Cop Rasmi:

Tarikh:

Tarikh:

*Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I hereby declared this report entitled “ON THE USE OF NANO FIBRILLATED CELLULOSE (NFC) FIBER AS REINFORCEMENT IN POLYLACTIC ACID (PLA) MATRIX COMPOSITES” is the result of my own research except as cited in reference.

Signature :

Author's Name : CARRON TING SHUANG SIA

Date :

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Engineering Materials) (Hons). The members of the supervisory committee are as follow:

.....
(Profesor Qumrul Ahsan)

.....
(Dr. Mohd Sukor Bin Salleh)

ABSTRAK

Tujuan penyelidikan ini adalah untuk menentukan hasil selulosa nano berserat (NFC) selepas proses hidrolisis asid, proses putaran mekanikal dan fibrilasi, untuk menganalisis morfologi pengedaran dan penyebaran NFC dalam NFC- PLA komposit dan untuk mengkaji kesan pengukuhan pada sifat mekanikal komposit NFC-PLA. Pada mulanya, gentian kenaf adalah dalam skala nano selepas perawatan kimia dan proses fibrilasi. Selepas itu, serat nano selulosa dengan pelet PLA mengalami tekanan panas untuk membentuk komposit NFC-PLA. Peratusan hasil NFC ditentukan dengan menggunakan kaedah sentrifugal. Penampilan morfologi pengedaran dan penyebaran NFC dalam komposit NFC-PLA diperhatikan dengan menggunakan mikroskop optik (OM) dan mikroskop elektron (SEM). Kesan pengukuhan pada sifat mekanik komposit NFC-PLA diselidiki dengan menggunakan ujian mekanikal iaitu tegangan. Untuk kajian ini, data analisis panjang dan diameter rata-rata gentian fibrilasi menunjukkan tren menurun kerana kelajuan pencampuran dan peningkatan masa. Peningkatan maksimum kekuatan tegangan sebanyak 59.32% diperhatikan untuk NFC-PLA yang komposit dengan gentian fibrilasi yang diperolehi dari kelajuan putaran dan masa 15000 rpm dan 15 minit berbanding dengan PLA tulen. Sifat tegangan menunjukkan bahawa kekuatan dan modulus telah bertambah baik dengan peningkatan kandungan nanofiber. PLA menunjukkan kekukuhan dan kekuatan yang baik dan digunakan dalam aplikasi seperti botol minuman, pembungkusan makanan dan beg plastik yang boleh rosak. Selulosa nano fibril yang diperkukuhkan di PLA dapat meningkatkan sifat mekaniknya. Kompleks NFC PLA terkenal digunakan sebagai bahan dalam industri percetakan 3D. Dengan mengurangkan penggunaan plastik konvensional, pembaziran tapak pelupusan boleh dikurangkan juga. Hal ini turut menyumbang kepada kehidupan atau amalan hijau yang membantu memulihara sumber semula jadi dengan mengurangkan penggunaan sumber yang tidak boleh dikembalikan dan tidak boleh diperbaharui.

ABSTRACT

This research is to determine the yield of nano fibrillated cellulose (NFC) after chemico mechanical treatments of natural fibers through acid hydrolysis, mechanical rotational and fibrillation process, to analyze the distribution and dispersion morphology of NFC in nano fibrillated cellulose poly lactic acid (NFC-PLA) composite and to investigate the reinforcing effect on mechanical properties of NFC- PLA composite. In the beginning, kenaf fibers were fibrillated nanoscale through chemical treatment and fibrillation process. After that, the nano cellulose fibers with PLA pellet undergo hot pressing to form NFC-PLA composite. The yield percentage of the NFC was determined using centrifugal method. For the NFC-PLA composite, the morphological appearance of distribution and dispersion of NFC in NFC-PLA composite is observed by using optical microscope (OM) and scanning electron microscope (SEM). The reinforcing effect on mechanical properties of NFC-PLA composite was investigated by using mechanical testing which is tensile test. For this research, analytical data of average length and diameter of fibrillated fibers show a trend of decreasing as the blending speed and time increase. The maximum increase in tensile strength of 59.32% was observed for NFC-PLA composite with fibrillated fiber derived from rotational speed and time of 15000 rpm and 15 minutes compared to pure PLA. The tensile properties indicated that the strength and modulus were improved with increased nanofiber contents. PLA shows good stiffness and strength and is being used in applications such as drinking bottles, food packaging and degradable plastic bags. The nano fibrillated cellulose reinforced in the PLA can further improve its mechanical properties. NFC PLA composite is well known used as material in the 3D printing industry. By reducing the usage of conventional plastics, the landfill wastage can be reduced as well. This contributes to green living or practices that help conserve natural resources by reducing the use of non-degradable and non-renewable resources.

DEDICATION

Only

My beloved father, William Ting Kee Seng

My appreciated mother, Wong Ngik Toh

My adored sister and brother, Ting Jin Sia and Ting Siew Yang

For giving me moral support, financial help, cooperation, encouragement and also understandings

ACKNOWLEDGEMENT

In the name of God, the most gracious, the most merciful, with the highest praise to Lord that I manage to complete this final year project successfully without difficulty.

My respected supervisor, Professor Qumrul Ahsan for his great mentoring throughout the project, I would like to show my gratitude for his kind supervision, advice and guidance as well as exposing me with meaningful experiences throughout the research.

I would like to give my thanks to my best friends who gave me so much motivation and cooperation mentally in completing this report. They had given their critical suggestion and comments throughout my research. Thanks for the great friendship.

I would like to thank each of everyone that helps me in this FYP report, as well as apologies that I could not mention personally each one of you.

TABLE OF CONTENTS

Abstrak	i
Abstract	ii
Dedication	iii
Acknowledgment	iv
Table of Contents	v
List of Tables	viii
List of Figures	ix
List of Abbreviations	xii

CHAPTER 1: INTRODUCTION

1.1	Background of Research	1
1.2	Problem Statement	3
1.3	Objectives	5
1.4	Scope of the Research	6

CHAPTER 2: LITERATURE REVIEW

2.1	Introduction to Composite	8
	2.1.1 Natural Fiber Reinforced Composite	9
	2.1.2 Polymer Matrix Composite	10
2.2	Properties of Polymer Matrix Composite	11
	2.2.1 Physical Properties of Polymer Matrix Composite	11
	2.2.2 Mechanical Properties of Polymer Matrix Composite	13
	2.2.3 Chemical Properties of Polymer Matrix Composite	16
2.3	Introduction to Fiber	17
	2.3.1 Kenaf Fiber	19
2.4	Nanotechnology	20
	2.4.1 Nano Cellulosic Fibers	21
2.5	Properties of Nano Cellulosic Fibers	22
	2.5.1 Physical Properties of Nano Cellulosic Fibers	22

2.5.2	Mechanical Properties of Nano Cellulosic Fibers	23
2.5.3	Characterization of Fiber Reinforced Polymer Matrix Composite	26
2.6	Extraction of Nanocellulose	26
2.7	Compression Moulding for NFC-PLA Matrix Composite	27
2.8	Effect of Dispersion of NFC in NFC-PLA Matrix Composite	29
2.9	Applications of Nanocomposite	30

CHAPTER 3: METHODOLOGY

3.1	Overview	31
3.2	Pretreatment of Kenaf Fiber	34
3.2.1	Chemical Pretreatment	35
3.2.2	Fibrillation	36
3.2.3	First Phase Sample Preparation	38
3.2.3.1	Vacuum Filtering	38
3.2.3.2	Oven Drying	39
3.3	Characterization of Fibrillated Nano Cellulose Fiber	40
3.3.1	Optical Microscopy (OM)	40
3.3.2	Scanning Electron Microscopy (SEM)	41
3.3.3	Field Emission Scanning Electron Microscopy (FESEM)	42
3.3.4	Fourier Transform Infrared Spectroscopy (FTIR)	43
3.3.5	Yield in Fibrillated Cellulose	44
3.4	Second Phase of Sample Preparation	45
3.4.1	Internal Mixer	45
3.4.2	Hot Pressing Moulding	45
3.5	Characterization of NFC-PLA matrix composite	46
3.5.1	Scanning Electron Microscopy (SEM)	46
3.5.2	Tensile Testing	47
3.6	Design of Experiment	48

CHAPTER 4: RESULTS AND DISCUSSIONS

4.1	Materials Characterization	49
4.1.1	Optical Microscopy (OM)	49
4.1.2	Scanning Electron Microscopy (SEM)	53

4.1.3	Field Emission Scanning Electron Microscope (FESEM)	60
4.1.4	Fourier Transform Infrared Ray (FTIR)	63
4.2	NFC PLA Polymer Matrix Composite Material Characterization	66
4.2.1	Scanning Electron Microscope (SEM)	66
4.2.2	Tensile Testing	67
CHAPTER 5: CONCLUSION AND RECOMMENDATIONS		
5.1	Conclusion	72
5.2	Recommendations	74
5.3	Sustainability Design Elements	74
REFERENCES		76
APPENDICES		81

LIST OF TABLES

2.1	Mechanical Properties of the Composite and pure PLA sample	13
2.2	Effect of Tensile and Flexural Properties Based on Fiber Loading	14
2.3	Mechanical Properties of Different Natural for Biocomposite Preparation	15
2.4	Chemical Composition of Various Natural Fibers	18
2.5	Tensile Strength (TS), Flexural Strength (FS) and Impact Strength (IM) of Macrocellulose, and Nanocellulose Reinforced Phenol Formaldehyde Composite at Various Fiber Loading	24
2.6	Effect of NaOH Concentration on Tensile Strength of WSK/EcoFlex Composites at 40% Fibre Loading	26
2.7	Comparison of Mechanical Properties PLA Composites Reinforced with Different Class of Fibres	27
3.1	Different Blending Speed and Times for Fibrillation Process	37
3.2	Design of Experiment for Fiber Type	48
3.3	Design of Experiment for Composition of Polymer Matrix Composite	48
4.1	Average Length and Diameter of Kenaf Fiber after Fibrillation Process at Various Blending Speed and Time	51
4.2	Average Diameter of NFC	61
4.3	Mechanical Properties of the NFC-PLA Composite	67

LIST OF FIGURES

2.1	Different Types of Composite	8
2.2	Illustration of the Phases of a Matrix Composite	10
2.3	SEM Micrographs of treated Kenaf Fiber Reinforced Epoxy (KRFE) after bending showing: a) Bent Fiber, b) Epoxy Coverage, c) Short Fiber Pull Out Length	11
2.4	Comparison of FTIR Spectra of Treated and Untreated WSK Fiber	16
2.5	Classifications of Fibers	17
2.6	Fiber Structure	18
2.7	Kenaf Plant	19
2.8	Structure of Kenaf Fiber	19
2.9	Classification of Nanocomposite Based on Nanocellulosic Materials	21
2.10	Morphological from the Scanning Electron Microscope of a) Raw Kenaf Fibers; b) Alkali-Treated Fibers; and c) Bleached Fibers	22
2.11	Tensile Modulus of PVA Nanocomposite	24
2.12	Tensile Strength of PVA Nanocomposite	25
2.13	SEM Images of Fracture Surface for P90-N2 AND P50-N2 Nanocomposites	26
2.14	Different Surface Treatment of Fiber	27
2.15	Nanocellulose and Some of the Current Applications	30
3.1	Flow Chart of Methodology for Fibrillation of Nano Cellulose	32
3.2	Flow Chart of Methodology for NFC-PLA Matrix Composite	33
3.3	Process Flow of Preparation of Nano Cellulosic Fiber from Kenaf	34
3.4	Set Up of Chemical Treatment for Kenaf Fiber	36
3.5	Vita Mix 5200 Blender	36
3.6	Vacuum Filtering Kit Set Up	38
3.7	Fibrillated Fibers Blended with Maximum Speed 23000 rpm and Blending Time of (A) 5 mins (B) 10 mins and (C) 15 mins	39
3.8	Oven	39

3.9	Optical Microscope	40
3.10	Scanning Electron Microscope	41
3.11	Sputter Coater Machine	41
3.12	Field Emission Scanning Electron Microscope	42
3.13	FTIR Analyzer	43
3.14	Hot Pressing Machine	45
3.15	DSES-1000	47
3.16	ASTM D638 Type I	47
4.1	OM Images of Fibers after Fibrillation Process after Various Speed and Time	50
4.2	Average Length of Kenaf Fiber Based on Different Blending Speed and Blending Time	51
4.3	Average Diameter of Kenaf Fiber Based on Different Blending Speed and Blending Time	52
4.4	The Differences Between (a) As Received Kenaf Fiber, (b) 3.7 wt% of HCL Solution Treated Kenaf Fiber and (c) 3.7 wt% of HCL Solution and 2 wt% of NaOH Treated Kenaf Fiber	54
4.5	Diameter of Fiber Based on Different Treatment	55
4.6	The Surface Morphology of Kenaf Fiber with Blending Time of 15 minutes and Blending Speed of (a) 7500 rpm, (b) 15000 rpm and (c) 23000 rpm Obtained from Scanning Electron Microscopy with Magnification of 1000X	56
4.7	Flow Chart of Treated Kenaf Fiber and Fibrillated Cellulose with Different Blending Speed of 7500, 15000 and 23000 rpm at 15 minutes	58
4.8	Formation of Nano Fibrillated Cellulose at 23000rpm, 5 minute.	60
4.9	Formation of Nano Fibrillated Cellulose at 23000rpm, 10 minute	60
4.10	Formation of Nano Fibrillated Cellulose at 23000rpm, 15 minute	61
4.11	Average Diameter of Fiber Based on Different Blending Time	62
4.12	FTIR Spectra Comparison between As Received Kenaf Fiber and Chemically Treated Fiber	63
4.13	FTIR Spectra Comparison between Chemically Treated Fiber and Fibrillated Fiber	63

4.14	FTIR Spectra of As Received Kenaf Fiber (KF-AR), Chemically Treated Fiber (KF-3T) and Fibrillated Fiber at Blending speed of 23000rpm at 15 minutes (KF-F23-15)	63
4.15	The Tensile Fracture Surfaces of (a) Pure PLA and Reinforced PLA Composites with NFC at (b) 7500 rpm, (c) 15000 rpm and (d) 23000 rpm for 15 minutes with Magnification of 200X	66
4.16	The Tensile Fracture Surfaces of (a) Pure PLA and Reinforced PLA Composites with NFC at (b) 7500 rpm, (c) 15000 rpm and (d) 23000 rpm for 15 minutes with Magnification of 1000X	66
4.17	Effect of Blending Time on Tensile Stress at 7500 rpm	68
4.18	Effect of Blending Time on Tensile Stress at 15000 rpm	68
4.19	Effect of Blending Time on Tensile Stress at 23000 rpm	69
4.20	Effect of Blending Speed on Tensile Stress at 5 minutes	69
4.21	Effect of Blending Speed on Tensile Stress at 10 minutes	70
4.22	Effect of Blending Speed on Tensile Stress at 15 minutes	70

LIST OF ABBREVIATIONS

NFC	-	Nano Fibrillated Cellulose
PLA	-	Poly Lactic Acid
FTIR	-	Fourier Transform Infrared Spectroscopy
OM	-	Optical Microscope
SEM	-	Scanning Electron Microscope
FESEM	-	Field Emission Scanning Electron Microscope
ASTM	-	American Society for Testing and Materials

CHAPTER 1

INTRODUCTION

Chapter 1 will be discussing the importance of nano fibrillated cellulose (NFC) based on NFC-PLA matrix biodegradable composite. The background of research describes about NFC, PLA and NFC-PLA polymer bio composite. Besides, the problem statement will show the research gap that will be reduced throughout the research which is mainly about the yielding of NFC and dispersion of NFC-PLA biodegradable composite. This section will point out the objectives of this research and its scope.

1.1 Background of Research

Synthetic polymers are widely used in various applications. As synthetic polymers are non-degradable, polymer pollution has become a serious matter. Hence, researchers are developing raw materials for polymers from renewable sources. Nowadays, most people are focusing to develop ecofriendly, natural degradable polymers. Biodegradable polymers can be categorized to two which are gas derived and microorganism derived polymers. For gas such as petroleum derived polymers, it is non-environmentally friendly because they emit greenhouse gases during the production. Whereas, microorganism derived biodegradable polymers utilize its bioactivity to produce a product for polymerization from plant source.

Poly lactic acid (PLA), the sample of this research is made by using the activity of microorganisms. This kind of polymer uses renewable feedstock and the production process releases carbon. PLA can be one of the most promising biodegradable polymers which have biocompatibility and good mechanical properties. It has tensile strength of 48 to 53MPa and modulus of 3500MPa (Jamshidian *et al.*, 2010).

However, the insufficient impact strength, inherent brittleness and low thermal stability of PLA are limiting the scope of its application. Strategies include copolymerization, polymer blends and addition of plasticizers, nanoscale reinforcing fillers and natural fibers. PLA polymers have a characteristic of aliphatic polyesters that absorb moisture which helps in its pathway of degradation. Biodegradable polymer degrades under aerobic condition which must have water and air exists so that the microbial biodegradation will take place.

In particular, cellulose nano fibrils (NFC) are ideal reinforcing materials for nanocomposites as they have high mechanical strength performance, high aspect ratio and large specific surface area. High quality of NFCs can be obtained at low cost through mechanical disintegration of wood pulp fiber after enzymatic or chemical pretreatments. When NFC is aligned, it can be a good reinforcement to its composites. Even though the nano fibers are randomly oriented, it might be possible to enhance the composites' properties (Jonoobi *et al.*, 2010). The NFC in the bio nanocomposite materials also gives enhancement in thermal stability because of a strong NFC bond that is formed within the matrix. (Karolina Larsson *et al.*, 2013) When compared to conventional fibers, natural fibers have the advantages of biodegradability, light weight and low environmental impact. Besides, when blends with polymer, it provides good mechanical properties to the polymer matrix composites.

Bio-reinforced green composites from renewable polymers and natural fibers have demonstrated substantially improved barrier properties, mechanical properties and thermal stability. Bio reinforced composite such as PLA with natural and man-made cellulose fibers such as wood pulp fibers, plant fibers from kenaf, flax, hemp, bamboo, ramie and even agriculture residues, regenerated cellulose fibers and recycled newspaper fibers have been prepared and extensively studied. Biodegradable polymers are other alternatives for petroleum derived polymers since they are overall biodegradable and renewable without releasing any toxic compounds to the environment (Alkbir *et al.*, 2016).

Biodegradable composites can be designed for automobile industry, conducting composite, barrier applications, drug delivery systems, building and construction industry, and adhesives (Saba *et al.*, 2015). There are two different applications for degradable polymers. The first is where biodegradability is part of the function of the product. Biodegradable plastics are used in bone fixation parts, drug release control system and compost bags (Rogina, 2014). As this composite has biodegradability property, it can be applied in preparing bioplastic that can be used for packaging, disposable tableware, compost bags and food packaging (Awadhiya *et al.*, 2017).

1.2 Problem Statement

NFC is abundantly available as in its raw materials are from plants. As for this research, NFC is fibrillated from chemically treated kenaf fiber. Instead of its abundant availability, NFC is not commercially available in large amount as it consumes time and the yield of it is low. The separation of nano cellulosic materials from plant sources gives a big challenge as it requires high energy. Other than that, the cellulose tends to absorb moisture which increases the challenge of fibrillation process. Based on the study by Li *et al.* (2017), the thermal degradation temperature of NFC is occurring around 200 to 300 degree Celsius which could be limitation to NFC applications.

The materials properties of virgin polymer will show significant improvement when nano fibers are well incorporated in polymer matrices. But most of the nano fibers are costly to produce, hardly to be recycled and does not degrade after its usage period. For this research, the nano fibers used are nano fibrillated cellulose. In composite world, it is vital for the reinforcement fibers to disperse evenly in the matrix for the material properties. Dispersion plays an vital role in improving the strength of biodegradable nanocomposites, as nanoscale particles that are separated homogenously will give better interfacial contact outcome between the matrix and the particles. It is hard to quantify the dispersion of NFCs as the nano fibers greatly blurred the crystalline texture. Hence, the mixing process is important to ensure full utilization of the reinforcing properties of the NFC. PLA, a biopolymer, is a non-polar and hydrophobic, which complicates the use of NFC as reinforcement since it has hydrophilic properties. One of the solving methods can be by dispersing the polymer particles in aqueous form and the matrix in latex form. This method enables direct wet mixing of the polymer particles and matrix in their dispersed state, thus preventing aggregation on drying.

In this research, different parameters of rotating speed will be used during the mechanical rotational process to obtain a higher yield of nanofiber cellulosic from the kenaf fibers. For a better dispersion of the NFC in PLA, it is important to have surface chemical reactions that are thermodynamically and kinetically favored in order to accomplish this.

1.3 Objectives

The objectives of this research are:

- a) To determine the yield of NFC after chemico mechanical treatment of natural fibers through acid hydrolysis, mechanical rotational and fibrillation process.
- b) To analyze the distribution and dispersion morphology of NFC in NFC- PLA composite.
- c) To investigate the reinforcing effect on mechanical properties of NFC- PLA composite.

1.4 Scopes of the Research

For this research, we will be focusing on the respective processes for the production of nano fibrillated cellulose which are through acid and alkaline hydrolysis and high speed rotating blender. NFC- PLA composite are to be prepared by internal mixer and hot compression molding.

The scopes of research are as follows:

- a) Research on the percentage yield of NFC through acid and alkaline hydrolysis and high speed rotational blending treatment. In this research will be focused more on utilizing distinctive parameter which resulting in high yield of NFC. It will utilize the use of mechanical rotational treatment fibrillation which is the high speed rotation blender. Before that, it will be treated with acid and alkaline hydrolysis.
- b) Analyze the morphological appearance in dispersion of NFC in NFC- PLA composite by utilising scanning electron microscope (SEM).
- c) Research on investigating the reinforcing effect on mechanical properties of NFC- PLA composite by using mechanical testing (Tensile Testing).

CHAPTER 2

LITERATURE REVIEW

In Chapter 2, it will mainly describe about nano fibrillated cellulose in biodegradable polymer to form biodegradable matrix composite. The details from previous studies are used as references and discussion was done based on their research regarding fibrillation of cellulose fibrils to nanoscale and dispersion of NFC in the NFC-PLA matrix composite. There are many ways that can extract the nanofiber cellulose such as various chemical treatment and mechanical treatment. For this research, acid treatment and mechanical treatment with different rotational blending speed will be used. As for the polymer matrix composite, different characterization techniques are used to identify its physical, chemical and mechanical properties.