

EFFECT OF PLA AS BONDING AGENT ON THE PROPERTIES
OF PINEAPPLE LEAF FIBRE-STARCH COMPOSITE

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OF PINEAPPLE LEAF FIBRE-STARCH COMPOSITE**

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**This report is submitted
in fulfillment of the requirement for the degree of
Bachelor of Mechanical Engineering (Structure & Materials)**

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DECLARATION

I declare that this project report entitled “Effect of PLA As Bonding Agent on The Properties of Pineapple Leaf Fibre-Starch Composite” is the result of my own work except as cited in the references

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SUPERVISOR'S 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 (Structure & Materials).

Signature :

Name of Supervisor : Dr. Mohd Zulkefli Bin Selamat

Date :

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ABSTRACT

Recent study has shown interest on green composite material based on plant fibre compared to the synthetic material due to its abundant supply source and renewable material. It also eco-friendly and does not bring harm to the human or environment due to its biodegradable nature. Pineapple Leaf Fibre (PLF) is one of the natural fibres that has abundantly supply resource that can be found in every part of the country. Due to its higher cellulose content which making a good mechanical properties compared to other fibres, PLF should not be wasted just like that. For this study, PLF is used as the reinforcement material while starch (SH) is used as the matrix material or binder. By adding Poly-Lactic Acid (PLA) as bonding agent, the adhesion of interface between the composite are hope to increase. Several compositions ratio of PLF/(SH/PLA) composites were tested in this project which are 50PLF/(50SH/PLA), 60PLF/(40SH/PLA) and 70PLF/(30SH/PLA). The fibre has gone through an alkaline treatment to increase the strength of the fibre. All the samples have gone through four different tests such as flexural test, hardness test, density test and macrostructure analysis to determine their mechanical properties. Based on the results, the sample with composition of 60PLF/(40SH/PLA) has the highest result for flexural stress which is 36.19 MPa. PLF with the composition 70PLF/(30SH/PLA) has the highest result in the hardness which is 60.7. In term of density measurement, the composition that shows higher result is 50PLF/(50SH/PLA) with the value of 1.228 g/cm³.

ABSTRAK

Kajian terkini telah menunjukkan minat kepada bahan komposit hijau berdasarkan serat tumbuhan berbanding bahan sintetik kerana ia mempunyai sumber bekalan yang banyak dan selain boleh diperbaharui. Ia juga mesra alam dan tidak membawa kemudaratan kepada manusia atau alam sekitar kerana sifat mesra alam itu. Serat Daun Nanas (PLF) adalah salah satu daripada gentian semula jadi yang mempunyai sumber bekalan yang banyak dimana ia boleh didapati di setiap bahagian di negara ini. Oleh kerana kandungan selulosanya yang lebih tinggi dan menghasilkan sifat mekanikal yang baik berbanding dengan gentian lain, PLF tidak boleh disia-siakan begitu sahaja. Untuk kajian ini, PLF digunakan sebagai bahan tetulang manakala kanji (SH) digunakan sebagai bahan matriks atau pengikat. Dengan menambah Asid Poli-Laktik (PLA) sebagai ejen ikatan, diharap lekatan antara muka antara komposit dapat meningkat. Terdapat beberapa nisbah komposisi bagi komposit PLF/(SH/PLA) telah diuji dalam projek ini iaitu 50PLF/(50SH/PLA), 60PLF/(40SH/PLA) dan 70PLF/(30SH/PLA). Gentian serat ini telah melalui rawatan alkali untuk meningkatkan kekuatan gentian. Semua sampel telah melalui empat ujian yang berbeza seperti ujian lenturan, ujian kekerasan, ujian ketumpatan dan analisis struktur makro untuk menentukan sifat-sifat mekanikal mereka. Berdasarkan keputusan, sampel, dengan komposisi 60PLF/(40SH/PLA) mempunyai hasil yang paling tinggi untuk tekanan lenturan iaitu 36.19 MPa. PLF dengan komposisi 70PLF/(30SH/PLA) pula mempunyai hasil yang tertinggi dalam ujian kekerasan dengan nilai 60.7. Dari segi pengukuran ketumpatan pula, komposisi yang menunjukkan hasil yang lebih tinggi adalah 50PLF/(50SH/PLA) dengan nilai 1.228 g / cm³.

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LIST OF ABBREVIATIONS

PLF	Pineapple Leaf Fiber
SH	Starch
PLA	Poly-Lactic Acid
PP	Polypropylene
MA	Maleic Anhydride
GFRP	Glass Fibre Reinforced Polymeric
CMC	Ceramic Matrix Composite
MMC	Metal Matrix Composite
PMC	Polymer Matrix Composite
CFRC	Ceramic Fibre Reinforced Ceramic
C	Carbon
SiC	Silicon Carbide
Al ₂ O ₃	Alumina
Al ₂ O ₃ –SiO ₂	Mullite
FRPs	Fibre Reinforced Polymers
T _g	Glass Transition Temperature
T _m	Melting Temperature
NaOH	Sodium Hydroxide
ASTM	American Standard Testing Method
sec	second
g	gram
min	minute
w.t	weight

LIST OF SYMBOLS

/	Per
$^{\circ}\text{C}$	Degree Celsius
%	Percent
g/cm^3	gram per centimetre cube
MPa	Mega-Pascal
$^{\circ}$	Degree
N	Newton
mm	millimetre
σ_f	Flexural Stress
ϵ_f	Flexural Strain
E_f	Modulus of Elasticity

CHAPTER 1

INTRODUCTION

1.1 Background

Green composites is actually a compound of polymers with the natural fibres and consist of two component which is binder and reinforced materials [1]. One acts as a structure and the other one as matrix inside the element. Green composite material based on plant fibre had given an intense competition to the synthetic material due to its abundant supply source and renewable material. It also eco-friendly and does not bring harm to the human or environment due to its biodegradable nature. In this study, the pineapple leaf fibre (PLF) will be the reinforced material and the starch (SH) as its binder. By adding poly-lactic acid (PLA) as bonding agent to this combination of two materials, the result will unveil some properties that are different from each material properties.

Since this study is about using PLF, SH and PLA as the materials to find their physical and mechanical properties, it is not wrong to say that the project is focused on to produce bio-degradable composites. Bio-degradable composites can be defined as a compound of bio-degradable matrix material reinforced with bio-degradable natural fibre [2]. The word bio-degradable itself brings a meaning that the material is eco-friendly material where it is easily degrade and the resources is renewable [3]. This awareness about bio-degradable composites is raised from the issues of reduction in petroleum resources as well as about the environmental problem [4]. Researcher come out with the alternative way to overcome this problem by using green materials associated with agriculture waste.

In industry such as plastic and packaging application, wide-range of oil-based polymer as well as many different materials are used including glass, metals, paper or pulp,

plastics or combinations of more than one material as compound. All of these material is surely not easily degrade and difficult to recycle or reuse. Waste from this industry contribute to a larger scale of solid waste where it brings a problem to the environment as well as the nature [5]. Figure 1.1 below shows the classification of bio-composites.

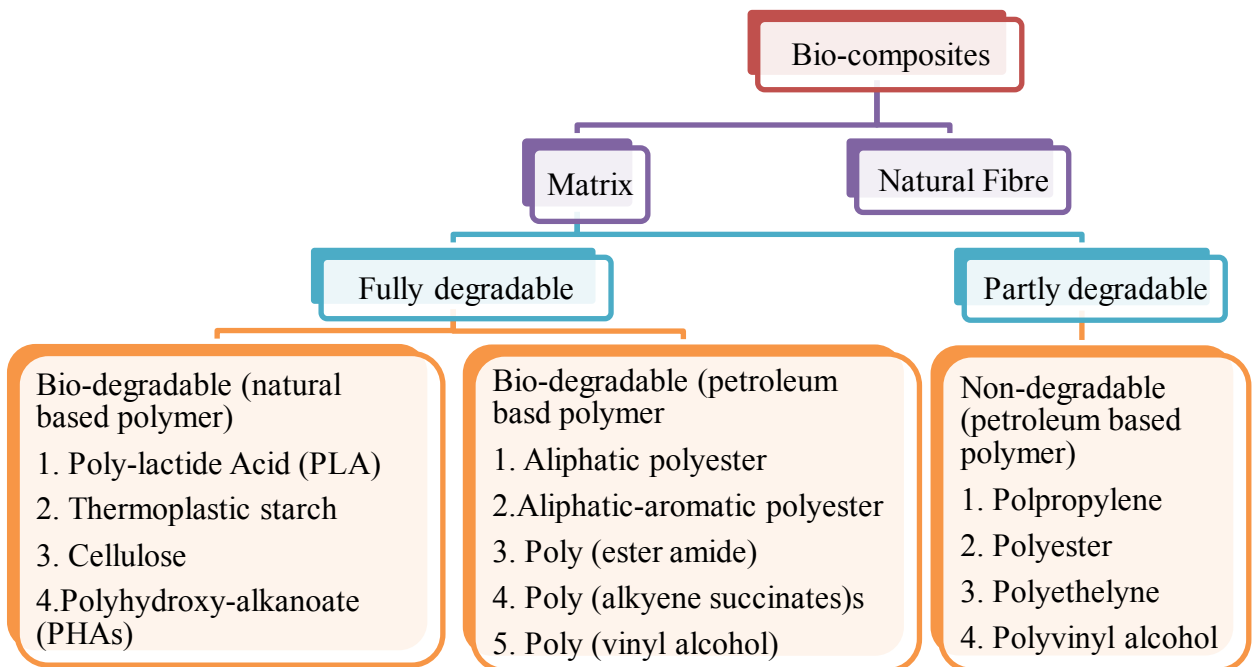


Figure 1.1 Classifications of bio-composites [6]

Previous research has shown about the potential to improve the composite performance by using resin-fibre interface but unfortunately the method is too costly and not safe for the environment [7]. The study about the composite by using PLF is also not new since scientist had discovered the good properties of compound between PLF and SH in term of mechanical and physical properties. However the result for properties is depended on the length of fibre used, the matrix ratio and also the arrangement of the fibre (orientation) [8]. Using natural fibre in reinforced composite instead of synthetic fibre reinforced composites is a good solution for improving the level of life while saving the nature.

Conversely, the utilization of natural fibre has several deficiency need to be considered. The PLF are receptive to humidity and has high moisture absorption [1]. The higher moisture of absorption will make the fibre swelling which brings to consequent loss of strength of the material thus leading to low mechanical performance of composite [7]. The fibre also has poor wettability with some polymer where it need to be taken care first before undergone any test. The solution to handle this is by doing treatment such as alkaline treatment to improve the surface of the fibre. The effect of PLA as bonding agent is to increase the interaction of adhesion between two compounds before using hot press compression moulding machine to produce the composite [9].

Strength and stiffness of the composite are generally increase with the increase of fibre loading as fibres are normally stronger and stiffer than matrix itself. Yet, this properties relies on having good fibre-matrix interfacial strength. Some cases like using hydrophobic matrices such as polypropylene (PP) reinforced with natural fibre, the resulted strength might be reduced. In this case, a bonding or coupling agent is needed to increase the interfacial adhesion between matrix and the fibre [10]. Bonding agents can be defines as a substances that are used in small quantities to treat a surface so that bonding occurs between it and other inter-surfaces [11]. Bonding agents will act as bridges that link composite constituents plus display strong secondary interactions [12]. Among material that being used as bonding agent are Maleic anhydride (MA), isocyanates and triazine. These materials are popular bonding agent that used under graft copolymerisation method where this method is involved with the reaction between the three stated material and cellulose [13].

1.2 Problem Statement

Previous study shows that fibre reinforced plastic is well known composite that being used in structure engineering. However, the used of synthetic fibre as material for reinforced composites will affect the environment and cause pollution to the soil as there are non-renewable, non-biodegradable and not eco- friendly even though it has good mechanical properties [14]. Compared with the synthetic fibre, natural fibre gives more advantages and easy to re-supply. It is low cost and weight, less damage to processing equipment and

improved surface finish of moulded parts composite [15]. The implementation of natural fibre in reinforced composite brings good effect in term of the performance and to the environment due to its biodegradable composite properties. The applications of natural fibre are growing in many sectors such as automobiles, furniture, packing and construction. From recent research shows that the current compound of PLF and SH had produce good combination result.

So in this project, the idea is to improve the result better than existing result by adding PLA as bonding agent or in other word as an additives to increase the matrix adhesion. The composition of PLA will be vary in the range of 20 up to 40 % in SH/PLA matrix. The compound then will be tested to determine the mechanical properties of the material. Next the focused will be on PLF/(SH/PLA) composite where combination SH/PLA as a matrix will be vary from 30 up to 50 %. In determining the effect of SH/PLA as a matrix in PLF/(SH/PLA) composite, the related tests will be conducted such as tensile or flexural test, hardness and density test plus macrostructure analysis. These all tests will determine about mechanical and physical properties of the composite.

1.3 Objective

The objective of this project are as follows:

1. To determine the effect of PLA as binder loading on the physical and mechanical properties of SH/PLA composition.
2. To determine the effect of PLF loading on the properties PLF/(SH/PLA) composite.

1.4 Scope of Project

The scope of this project is to study the effects of PLA loading on the mechanical properties of PLF / SH composite with the selected ratio of composition between them. The composite was fixed to 70/30, 60/40 and 50/50. Before that, an alkaline treatment will be conducted first to extract thin PLF bundles. Besides, this process is needed to enhance the PLF properties before using hot-press compression moulding machine to form the structure. The mechanical properties that are going to be determined from the experiment are tensile test, flexure test, hardness test, density measurement and macrostructure analysis. To achieve the objectives, the correct method to prepare the specimen need to be emphasized and understand clearly.

CHAPTER 2

LITERATURE REVIEW

2.1 Composite

Composites are one of the most widely used materials because of their adaptableness to vary situations and the relative ease of combination with other materials to achieve specific purposes and show desired properties. The constituent that make up a composite materials are known as binder or matrix inside the element and reinforcement [16]. Reinforcement material provide the structural rigidity while the matrix will hold the component together.

Undeniably, the competitiveness of green composite material is increasing greatly since it has abundant source, good to nature, low cost besides the properties that they exhibit almost has same quality as the synthetic glass fibre reinforced polymeric (GFRP) composite [7]. Since the purpose of composite is to let the new material possess a strength from the combination, no wonder all these composites had been widely used in electronics, aviation, automobile and many other application due to their excellent properties.

2.1.1 Types of composites

Composite material can be divided into 3 sub-group according the material used where all the purpose is to enhance the matrix properties. The 3 sub-group are: