STUDY ON MECHANICAL PROPERTIES AND MORPHOLOGY OF BANANA-GLASS FIBRE REINFORCED POLYPROPYLENE (PP) HYBRID COMPOSITES

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Study on Mechanical Properties and Morphology of Banana-Glass Fibre Reinforced Polypropylene (PP) Hybrid Composites

Thesis submitted in accordance with the requirements of the
Universiti Teknikal Malaysia Melaka for the Degree of
Bachelor of Manufacturing Engineering
(Engineering Material)

By

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April 2009

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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JUDUL: **STUDY ON MECHANICAL PROPERTIES AND MORPHOLOGY OF BANANA-GLASS FIBRE REINFORCED POLYPROPYLENE (PP) HYBRID COMPOSITES**

SESI PENGAJIAN: **2005/2009**

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APPROVAL

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ABSTRACT

The goal of our research was study about the mechanical properties and morphology of banana-glass fibre reinforced polypropylene hybrid composites. In this study, we choose the banana fibre as first material. This is because, banana trunk are the natural material and easy to get at any place in Malaysia and other place in the world. Preparations for banana fibre are getting from the journal. Before mixing the composition, banana fibre were processes via extraction banana fibre from the trunk of banana. The processing of banana fibre is for different two sizes; 250µm and 500µm. While, the composition prepared with 1.5, 2 and 2.5wt% of banana fibre .Then constant the composition and length of glass fibre at 5wt% and 2.5mm. After that, these compositions are tested for mechanical properties and their morphology. Overall of the observation from this study shows the natural fibre have good mechanical properties when mixing with synthetic fibre.

ABSTRAK

Tujuan utama projek ini bagi mengkaji sifat mekanikal dan morfologi campuran antara dua gentian; gentian kaca dan gentian pisang bersama matrik polipropilina. Gentian pisang menjadi bahan utama didalam kajian ini kerana ia merupakan bahan semulajadi yang senang didapati dimerata-rata tempat, khususnya di seluruh Malaysia dan amnya di seluruh dunia. Penyediaan gentian pisang ini diperoleh dari kajian yang terdapat di dalam jurnal yang di akses melalui internet. Sebelum campuran komposit ini difabrikasikan, pemprosesan gentian pisang dijalankan dengan mengekstrak gentian pisang dari batang pisang yang matang. Gentian pisang ini diproses kepada dua panjang yang berbeza, ia itu 250µm dan 500µm. Manakala, campuran yang dibuat pula mengikut komposisi muatan gentian 1.5, 2 dan 2.5wt% dengan mengekalkan komposisi muatan gentian kaca pada 5wt% dengan panjang 2.5mm. Campuran ini kemudiannya di fabrikasi dan diuji terhadap ciri-ciri mekanikal dan analisis morphologi. Pemerhatian secara keseluruhan, dari hasil kajian ini menunjukkan bahan gentian semulajadi mempunyai ciri-ciri mekanikal yang baik apabila digandingkan dengan bahan sintetik.

DEDICATION

For my beloved mother and father also to my family who always give me support:

Mohammad b Mahmood

Hawayah bt Mohamad

Mohd Hazizie b Mohammad

Mohd Nasruddin b Mohammad

Mohd Shaziman b Mohammad

Nor Shafiqah bt Mohammad

Nor Shahirah bt Mohammad

Nor Shafarina bt Mohammad

Nor Shamine Aida bt Mohammad

Siti Ummi Umairah bt Mohammad

Nurul Najwa Tasnim bt Mohammad

ACKNOWLEDGEMENTS

In the name of Allah SWT, finally I have completed my thesis based on the knowledge and experience that I got during my entire project. Here I would like to take this opportunity to thank the people for their utmost help and guidance given to me. I sincerely appreciate the following people for their utmost cooperation to me during my project flow.

- Dean, Head of Department, Lecturers and Technician of Manufacturing Engineering Faculty who had always given me their undivided guidance and corrected my mistakes during doing my PSM.
- I extend my appreciation to the respective Pn. Intan Sharhida bt Othman, my project supervisor who has shared her knowledge and experience as well as give me information and also given me full support and guidance in order to build my confidence and ability while doing my project.
- My panel lecturers who will conduct the secondary evaluation for my PSM
- Last but not least, my Colleagues and friends in Bachelor Manufacturing Material Engineering who were always keep in touch and guide me during the project.

This project is dedicated to everyone who was involved while I am doing the project because without his or her help and support, I would not have been able to create this project successfully.

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

ASTM	-	American Standard Testing Material
UTM	-	Universal Testing Machine
UTM	-	Universal Testing Machine
Max	-	maximum
Min	-	minimum
^{0}C	-	degrees Celsius
%	-	Percent
SEM	-	Scanning Electron Microscope
PP	-	Polypropylene
^{0}C	-	degrees Celsius
G	-	Giga
M	-	Mega
Pa	-	Pascal
Wt%	-	Weight Percent

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

1.1 Background

In recent years, polymeric based composites materials are being used in many application such as automotive, sporting goods, marine, electrical, industrial, construction, household appliances, *etc.* Polymeric compositess have high strength and stiffness, light weight, and high corrosion resisitance. Natural fibres are available in abundance in nature and can be used to reinforce polymers to obtain light and strong materials. The information on the usage of banana fibre in reinforcing polymers is limited in the literature. In dynamic mechanical analysis, have investigated banana fibre reinforced polyester composites and found that the optimum content of banana fibre is 40%. The analysis of tensile, flextural, and impact properties of these composites revealed that composites with good strength could be successfully developed using banan fibre as the reinforcing agent. The source of banana fibre is the waste banana trunk or stems which are abundant in many places in the world (Sapuan, 2005).

Nature continues to provide mankind generously with all kinds of rich resources in plentiful abundance, such as natural fibres from a vast number of plants. However, since the last decade, a great deal of emphasis has been focused on the development and application of natural fibre reinforced composite material in many industries. Needless to say, due to relatively high cost of synthetic fibres such as, glass, plastic, carbon and kevlar used in fibre reinforced composite, and the health hazards of abestos fibres, it becomes necessary to explore natural fibre, like banana fibres (Al-Qureshi, 1999).

The natural fiber present important advantages such as low density, appropriate stiffness, mechanical properties with high disposability and renewability. In this project are used the natural fiber of banana. Moreover, these banana fiber are recycle and biodegradable. These have been lot of research on use of natural fiber in reinforcement. Banana fiber, a ligno-cellulosic fiber, obtained from the pseudo-stem of banana plant (Musa sepientum), is a bast fiber with relatively good mechanical properties. In tropical countries like Malaysia, fibrous plants are available in abundance and some of them like banana are agricultural crops. Banana fiber at present is a waste product of banana cultivation. Hence, without any additional cost input, banana fiber can be obtained for industrial purposes. Banana fiber is found to be good reinforcement in polypropylene resin. The properties of the composites are strongly influenced by the fiber length (Samrat, 2008).

1.2 Problem Statement

The problem statement the research is to find the composition of natural fiber with polypropylene reinforce composite in the several factors such as mechanical properties and physical properties. Banana fiber is a natural fiber thus has the potential to substitute fiberglass and other synthetic fibers that are currently used. Previous researches on banana have found that many good mechanical properties. The good properties of banana fiber include good specific strengths and modulus, economical viability, low density and low weight. In this project, the effect of the fiber length and volume can affect the properties of the composite produced.

1.3 Objectives

i. Investigate the mechanical properties of banana-glass fibre reinforced polypropylene hybrid composite at different fibre loading and also sizes.

ii. Study the morphology of banana-glass fibre reinforced polypropylene hybrid composite at different fibre loading.

iii. Find the optimum composition of banana fibre and polypropylene in hybrid composite.

1.4 Scope of study

Before fabricate the composite, the banana trunk must be process first to find the fiber. The banana fibres were process using the Rotor Machine to find the different sizes of banana fibers. The fabrication process involved Mixer Machine and the Hot Press Machine to produce the composite. Then the mechanical test and physical test are carried out on this composite. The tests that involved are impact test, tensile test, flexural test and water absorption test. The morphology of this composite observed by using the Scanning Electron Microscope (SEM).

CHAPTER 2

LITERATURE REVIEW

2.1 Composite

2.1.1 Introduction

Composite materials are engineered material made from two or more constituent materials with significantly different physical or chemical properties and which remain separate and distinct on a microscopic level within the finished structure. The are two categories of constituent materials there are matrix and reinforcement. At least one portion of each type is required. A synergism produces material properties unavailable from the individual constituent materials, while the wide variety of matrix and strengthening materials allows designer of the product or structure to choose an optimum combinations. Engineered composite materials must be formed to shape. A variety of molding method can be used according to the design requirements. The principal factors impacting the methodology are the natures of the choose matrix and reinforcement materials. Another important factor is the gross quantity of material to be produced (Callister, 2005).

Large quantities can be used to justify high capital expenditures for rapid and automated manufacturing technology. Small production quantities are accommodated with lower capital expenditures but higher labor and tooling cost at a correspondingly slower rate. The physical properties of composite materials are generally not isotropic in nature, but rather are typically orthotropic. For instance, the stiffness of a composite panel will often depend upon the directional orientation of the applied forces and moments. Panel stiffness is also dependent on the design of the panel (Callister, 2005).

2.1.2 Matrix

2.1.2.1 Introduction

The matrix material surrounds and supports the reinforcement materials by maintaining their relative positions. The matrix holds are fiber together. Even through, the fibers are strong, they can be brittle. The matrix can absorb energy by deforming under stress. This is to say, the matrix adds toughness to the composite. While fibers have good tensile strength, they usually haw awful compression strength. The matrix gives compression strength to the composite. The matrix materials can be introduced to the reinforcement before or after the reinforcement materials is placed into the mold cavity or onto the mold surfaces. The matrix materials experience a melding event, after which the part shape is essentially set. Depending upon the natural of the matrix materials, this melding event can occur in various ways such as chemical polymerization or solidification from the melted state (Callister, 2005).

2.1.2.2 Thermoset

Thermoset polymers become permanently hard when heats is applied and do not soften upon subsequent heating. During the initial heat treatment, covalent crosslinks are formed between adjacent molecular chains; these bonds anchor the chins together to resist the vibration and rotational chain motions at high temperatures. Crosslinking is usually extensive, in that 10 – 50% of the chain polymer units are crosslinked. Only heating to excessive temperatures will cause severance of these crosslink bonds and polymer degradation. Thermoset polymers are generally harder and stronger than thermoplastics, and have better dimensional stability. Most of the crosslinked and net work polymers, which include vulcanized rubbers, epoxies and phenolic and some polyester resins, are thermosetting (Callister, 2005).

2.1.2.3Thermoplastic

The thermoplastic soften when heated (and eventually liquefy) and harden when cooled-processes that are totally reversible and may be repeated. On a molecular level, as the temperature is raised, secondary bonding forces are diminished (by increased molecular motion) so that the relative movement of adjacent chains is facilitated when a stress is applied. Irreversible degradation results when the temperature of a molten thermoplastic polymer is raised to the point which molecular vibrations become violent enough to break the primary covalent bonds. In addition, thermoplasts are relatively soft. Most linear polymers and those having some branched structures with flexible chains are thermoplastic. These materials are nomally fabricated by the simultaneous application of heat and pressure (Callister, 2005).

i. Polypropylene

Kahraman *et al.* (2005) revealed that polypropylene is mostly used as one of the constituentts in composites compared to other thermoplastics due to its superior properties as well as easy processibility by all processing methods such as molding, extrusion, film and fibre manufacturing. This is also agree by Mohanty *et al*. (2002). In comparison to polyethylene, Kahraman (2005) also ponted out that polypropylene has far superior in terms of heat resistance and mechanical properties, perticularly its low density makes its especially attractive in lightweight applications that require strength. In terms of compatibility with natural fibres, poly[propylene has also showed the most potential benefits of all the thermoplastics matrices available when combined with natural fibres in making composites for industrial application (Mohanty *et al.*,2002).

The pendant methylene group in Polypropylene is replaced by a chlorine atom in polyvinyl chloride (PVC), by a benzene ring in polystyrene (PS) and by a hydrogen atom in polyethylene (PE). The pendant group significantly affects the properties of the polymer, and consequently the properties of PP are very different from other commodity plastic such as PE, PVC and PS (Devesh, 2002).

In 1957, Polypropylene was commercially produced by Montecatini as Moplen. Recently, metallocenes have attracted widespread attention as the new generation of olefin polymerization catalysts. Metallocene catalysts provide enhanced control over the molecular make up of Polypropylene, and grades with extremely high isotacticity and narrow molecular weight distribution (MWD) are possible (Devesh ,2002).

a. Major Advantages

Polypropylene is very popular as a high-volume commodity plastic. However, it is referred to as a low-cost engineering plastic. Higher stiffness at lower density and resistance to higher temperatures when not subjected to mechanical stress (particular in comparison to high and low density PE (HDPE and LDPE) are the key properties. In addition to this, Polypropylene offers good fatigue resistance, good chemical resistance, and good environmental stress cracking resistance, good detergent resistance, and good hardness and contact transparency and ease of machining, together with good processibility by injection moulding and extrusion (Devesh,2002).

Table 2.1 shows the comparison of unmodified PP with other material. The properties of PP at specific density is very low than others, than the maximum continuous use temperature are highest at 100 ^{0}C. The costs for PP are cheaper than others material. That why, this project chooses the PP as a matrix for composites.

Table 2.1 : Comparison of unmodified PP with other materials : Advantages

Property	**PP**	**LDPE**	**HDPE**	**HIPS**	**PVC**	**ABS**
Flexural modulus (GPa)	1.5	0.3	1.3	2.1	3.0	2.7
Tensile strength (MPa)	33	10	32	42	51	47
Specific density	0.905	0.92	0.96	1.08	1.4	1.05
Specific modulus (GPa)	1.66	0.33	1.35	1.94	2.14	2.57
HDT at 0.45 MPa (^{0}C)	105	50	75	85	70	98
Maximum continuous use temperature (^{0}C)	100	50	55	50	50	70
Surface hardness	RR90	SD48	SD68	RM30	RR110	RR100
Cost (£/tonne)	660	730	660	875	905	1550
Modulus per unit cost (MPa/£)	2.27	0.41	1.97	2.4	3.31	1.74

(Devesh ,2002)

b. Major Disadvantages

The major disadvantages of unmodified Polypropylene compared with other competitive thermoplastics are evident from Table 2.2. It can be seen that Polypropylene has significantly higher mould shrinkage, higher thermal expansion and lower impact strength, particularly at sub-ambient temperatures, than HIPS, PVC and ABS. However, Polypropylene has lower mould shrinkage and thermal expansion coefficient than HDPE