UNIVERSITI TEKNIKAL MALAYSIA MELAKA

A MECHANICAL STUDY ON COCOA HUSK – GLASS FIBRE/ POLYPROPYLENE (PP) HYBRID COMPOSITE

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

By

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Faculty of Manufacturing Engineering

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ABSTRACT

This research presents the ‘Mechanical Study on Cocoa husk – glass fiber/ polypropylene (PP) hybrid composite. The purposes of doing this research are to determine the effect of various fiber loading and fiber sizes of cocoa husk into mechanical properties of cocoa husk- glass fiber / polypropylene hybrid composite and to analyze the morphology behaviour of the hybrid composite in relation to their mechanical properties. In this project, the cocoa husk particles, E-glass fiber with the length of 3mm and polypropylene pellet are used to form hybrid composite with the weight ratio 88.33/5/6.67, 86.66/6.67/6.67, and 85/8.33/6.67. The size of cocoa husk particles was characterized by using Laser Particle analysis. The specimens were fabricated by using the Internal Mixer, crusher and compression-moulding machine to form the composite sheet. The composite sheets were then cut into the dimension as required by ASTM standard. The specimens were divided two categories; one was subjected to mechanical testing and another one was subjected to water absorption testing. The effects of cocoa husk fiber loading and size fiber on the tensile properties, flexural properties and impact properties of the specimen were observed. The dry specimens were then further analyzed with the morphology analysis on the microstructure surface of the specimen by using the SEM. The results showed that the cocoa husk fiber filled composite had increased the tensile strength and tensile modulus as the cocoa husk fiber increased. The optimal flexural properties of the PP/E-glass/cocoa husk hybrid composite were found at the weight ratio of 88.33/5/6.67 with the size of 250µm. the morphology behaviours showed that the bonding between E-glass and matrix are poor and the structure of cocoa husk that embedded with composite are not see clearly. It shows that the bonding between cocoa particle and matrix are stronger than E-glass. To solve the problems and to increase the bonding of fiber and matrix, the coupling agent is need to be use for cocoa husk and E-glass. The fabrications of sample were giving an effect to the final results. From the observation, it shows that defects

such as bubbles, impurity and unmelted material were decreased the ability of the composite materials.

ABSTRAK

Kertas kerja ini menerangkan mengenai projek bertajuk ‘Kajian mekanikal pada komposit hibrid pada gentian koko- kaca-E/polipropelene (PP)’. Tujuan menjalankan kajian ini adalah untuk menentukan kesan perbezaan sifat mekanikal pada PP/kaca-E komposit jika serbuk koko ditambah dengan peratus pengisian yang berbeza dan mengkaji sifat morfologi pada PP/kaca-E/ koko komposit hybrid pada nisbah berat ; 88.33/5/6.67, 86.66/6.67/6.67, dan 85/8.33/6.67. Saiz pada serbuk koko ditentukan melalui analisis laser mikroskop. Komposit hibrid dibentukkan ke dalam kepingan dengan menggunakan mesin pencampur dalaman, penghancur dan pemampat. Kepingan komposit yang dihasilkan seterusnya dipotong berdasarkan dimensi yang ditetapkan dalam ASTM. Sampel yang dihasilkan telah dibahagikan kepada dua kumpulan iaitu ujian mekanikal dan ujian penyerapan air. Kesan-kesan setiap pengisian koko pada sifat mekanikal seperti sifat ketegangan, sifat kelenturan dan sifat tahan kejutan pada sampel ditentukan melalui ujian-ujian mekanikal. Kemudian, sifat morfologi menunjukkan penambahan pengisian serbuk koko ke dalam komposit meningkatkan sifat ketegangan. Sifat kelenturan pada komposit hibrid didapati paling optima pada nisbah berat 88.33/5/6.67 pada saiz pengisi, 250μm. sifat morfologi didapati mempunyai ikatan yang lemah diantara kaca-E dengan matrik dan pada ikatan koko tidak kelihatan pada permukaan komposit. Untuk mengatasi masalah ini, bahan kimia digunakan untuk menguatkan lagi ikatan diantara kaca-E dengan matrik. Penghasilan sampel boleh mempengaruhi kekuatan komposit. Kebanyakan daripada sampel didapati mempunyai kecacatan seperti rongga udara, bendasing dan bahan tidak melebur sepenuhnya. Dengan wujudnya kecacatan ini, ia akan mengurangkan kekuatan ikatan pada komposit .

DECLARATION

I hereby declare that this report entitled **"A MECHANICAL STUDY ON COCOA HUSK-GLASS FIBER/ POLYPROYLENE (PP) HYBRID COMPOSITE"** is the result of my own research except as cited in the references.

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APPROVAL

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LIST OF ABBREVIATIONS, SYMBOLS, NOMENCLATURES

PP	-	Polypropylene
SEM	-	Scanning Electron Microscope
ASTM		American Society of Testing Materials

CHAPTER 1

INTRODUCTION

1.1 Research Background

A characteristic feature of today's modern technology and market-oriented economy is the excessive and exponentially increasing usage of polymer composites in all fields of industry. The reason for this phenomenon can be explained by the favourable price/weight ratio. The automotive industry is developing most dynamically since a serious weight decrease can be achieved by using polymer composites and hence fuel can be saved and damage to the environment decreases. It is possible to make completely new types of composite materials by combining different resources.

The objective will be to combine two or more materials in such a way that a synergism between the components results in a new material that is better than the individual components. One of the big new areas of development is in combining natural fibres with thermoplastics. Since prices for plastics have risen sharply over the past few years, adding a natural powder or fibre to plastics provides a cost reduction to the plastic industry and in some cases increases performance as well, but to the lignocelluloses- based industry, this represents an increased value for the lignocelluloses-based component (Rowell *et al*, 1999).

Any substance such as natural fibre and other plant that contains both cellulose and lignin is lignocelluloses. In general, wood is also in type of other lignocelluloses even though they may differ in chemical composition and matrix morphology. The main of composite development is to produce a new product with excellent performance in characteristics that combine the positive attributes of each constituent component. Like other lignocelluloses material, nature fibre is strong, lightweight, abundant, nonhazardous and relatively inexpensive. Any lignocelluloses can be chemically modified to enhance properties such as dimensional stability and resistance to bio-deterioration. This provides a new improvement in cost and performance of value-added from different raw materials (Gilbert *et al*, 1994).

The main limitation by using the lignocelluloses fibres is the lower processing temperature permissible due to the possibility of fibre degradation and/or the possibility of volatile emissions that could affect composite properties. The processing temperatures are thus limited to about 200°C, although it is possible to use higher temperatures for short periods. This processing factor limits the type of thermo-plastics that can be used with lignocelluloses fibres; to commodity thermoplastics such as polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC) and poly-styrene (PS). However, it is important to note that these lower-priced plastics constitute about 70% of the total thermoplastic consumed by the plastics industry, and consequently the use of fillers/reinforcement presently used in these plastics far out-weigh the use in other more expensive plastics. In the way to make a better mix with the hydrophore (plastic) in the hydrophil (lignocelluloses), there are two basic area; one in which no attempt is made to compatibilize the two dissimilar resources and, a second in which a compatibilizer. In the first case, the lignocelluloses fibre is added as relatively of low cost filler and in the second, the lignocelluloses fibre is added as reinforce filler. Both of these types of materials are usually referred to as natural fibre/thermoplastic blends (Rowell *et al*, 1999).

Several million metric tons of fillers and reinforcements are used annually by the plastics industry. The use of these additives in plastics is likely to grow with the introduction of improved compounding technology, and new coupling and compatibilizing agents that permit the use of high filler/reinforcement content. As suggested by Katz *et al.* (1987), fillings up to 75 parts per hundred (pph) could be common in the future. This level of filler could have a tremendous impact in lowering the usage of petroleum-based plastics. It would also be particularly beneficial; both in terms of the environment and also in socioeconomic terms, if a significant amount of the fillers were obtained from a renewable agricultural source (Anand, R. *et al*, 1997).

1.2 Problem Statement

In worldwide, the usage of any substance of natural fibre such as wood agricultural crops, like jute or kenaf; agricultural residues, such as bagasse or corn stallus; grasses; and other plant substances are getting increase to produce new products. From the wasted materials, it becomes a useful product to replace the old materials. In manufacturing sector especially in healthy and food, the natural fibre is most popular material usage in producing cosmetic and food for animal. Many sectors have been use cocoa husk as the addition of ingredient. In manufacturing food products, the cocoa husk was suggested as an ingredient in foods (Bonuchi J.S. *et al*, 1999).Today, the natural fibre is mostly use as addition materials for produce a product such as cotton, recycles paper, cabinet and so on. In general, the mechanical and physical properties of natural fibre reinforced plastic only conditionally reach the characteristic values of glass-fibre reinforced system. By hybrid composites, in using of natural fibre and carbon fibre/ glass fibre as the reinforcement is adding with the polymer (Polypropylene) as a matrix the properties of natural fibre reinforced composite.

A wasted materials are rarely use in manufacturing. Some other can be used and a less is wasted. Cocoa husk pod is category of wasted material use in food manufacturing cocoa. Cocoa husks, when properly processed, serve as animal feeds and can be burnt to produce potash for making soft soap (Owolarafe, O.K, *et.al*, 2007).

But, now, some of researcher uses the cocoa husk for produce cosmetic and preparation food animal. In this research, cocoa husk will use to combine the synthetic fibre and matrix polymer to reveal the properties in mechanical and physical. In this research, the cocoa pod husk as natural fibre will adds with glass-fibre/polypropylene to get new mixture materials. Hence, the testing and analysis will be done to investigate the strength of hybrid composite in mechanical and physical properties. From that, the characteristics of hybrid composite can be use for producing products that due to economic today.

1.3 Objectives

a) To investigate the effect of various fiber loading and fiber sizes of cocoa husk into mechanical properties of cocoa husk-glass fiber/polypropylene hybrid composite.
b) To analyze the effect of water absorption of cocoa husk-glassfiber/ polypropylene hybrid composite.
c) To investigate the morphology of cocoa husk-glassfiber/ polypropylene hybrid composite.

1.4 Scopes

a) To prepare the sizes of cocoa husk in three types; 45µm, 250µm and 500µm.
b) To fabricate the specimen of cocoa husk-glassfiber/ polypropylene hybrid composite.
c) To identify the feasibility of cocoa husk (wasted material) reinforced glass fiber/polypropylene hybrid composite on impact resistance.
d) To find the strength of mechanical and physical properties on cocoa husk-glassfiber/ polypropylene hybrid composite.
e) To identify the ability of water absorption on cocoa husk-glassfiber/ polypropylene hybrid composite.
f) To analyze the morphology of the particular composite by using Scanning electron microscope (SEM)

CHAPTER 2

LITERATURE REVIEW

2.1 Composite

2.1.1 Introduction

Nowadays, the request and needs of high performances materials such as composite are increase due to the rapid development in manufacturing. Despite the fact that composites are generally more expensive in comparison to traditional construction materials, and therefore not as widely used in many constructive and building activities, they have the advantage of being lightweight, more corrosion resistant and stronger. The fibre reinforcements provide good damping characteristics and high resistance to fatigue. Over the last thirty years composite materials, plastics, and ceramics have been the dominant emerging materials. The volume and number of applications of composite materials has grown steadily, penetrating and conquering new markets relentlessly. Modern composite materials constitute a significant proportion of the engineered materials market.

Composite is define as a combination of two or more materials (reinforcing elements, fillers, and composite matrix binder), differing in form or composition on a macro scale. The constituents retain their identities, that is, they do not dissolve or merge completely into one another although they act in concert. Normally, the components can be physically identified and exhibit an interface between one another. Examples are cermets and metal-matrix composites. Composite materials are constantly being adapted to the way that they are used. As a result, there are a wide variety of composites to choose from, thanks to the ever-changing technological advances that make it possible to apply Composite Engineering. As a result, each type of composite brings its own performance characteristics that are typically suited for specific applications. In modern materials of engineering, the term of composite is usually refers to a matrix material that is reinforced with fibers. For instance, the term FRP (Fiber Reinforced Plastic) usually indicates a thermosetting polyester matrix containing glass fibers (Roylance, 2000).

2.1.2 Matrix

2.1.2.1 Introduction

Most basic form a composite material is one, which is composed of at least two elements working together to produce material properties that are different to the properties of those elements on their own. In practice, most composites consist of a bulk material matrix, and a reinforcement of some kind, added primarily to increase the strength and stiffness of the matrix. This reinforcement is usually in fibre form. Today, the most common man-made composites can be divided into three main groups (Callister, 2003).

(a) Polymer Matrix Composites (PMC’s)

PMC that consists of glass, carbon and aramid in a thermoset or thermoplastic are provided strong, stiff and corrosion resistant. It also known as FRP Fibre Reinforced Polymers or Plastics that use as polymer-based resin in the matrix (Anonymous 1, 2001).

(b) Metal Matrix Composites (MMC’s)

MMC is a continuous metallic phase (matrix) where is combined with another phase (reinforcement). Increasingly found in the automotive industry, these materials use a metal such as aluminium as the matrix, and reinforce it with fibres such as silicon carbide. Most of MMC exhibited such as lower density, increased specific strength and stiffness, increase high temperature performance limits and improved wear abrasion resistance (Anonymous 2, 2009).

(c) Ceramic Matrix Composites (CMC's)

CMC is combinations of reinforcing ceramic phases with a ceramic matrix to create materials. This material is produced a new properties in structural part such as rocket and jet engines. The characteristic of CMC are including high temperature, stability, high thermal shock resistance, high hardness, and high corrosion resistance and so on. Anyway, it used in very high temperature environments where these materials use a ceramic as the matrix and reinforce it with short fibres, or whiskers such as those made from silicon carbide and boron nitride (Naslain, 2009).

2.1.2.2 Termoset/ Thermosetting

Thermosetting plastics (thermosets) are polymer materials that irreversibly cure to a stronger form. The cure may be done through heat (generally above 200 degrees Celsius), through a chemical reaction (two-part epoxy, for example), or irradiation such as electron beam processing. Thermoset materials are usually liquid or malleable prior to curing and designed to be molded into their final form, or used as adhesives. Others are solids like that of the molding compound used in semiconductors and integrated circuits (IC's).

Thermosetting polymers become permanently hard when heat is applied and do not soften upon subsequent heating. During the initial heat treatment, covalent crosslink are formed between adjacent molecular chains; these bonds anchor the chains together to resist the vibration and rotational chain motions at high temperature. Crosslinking is usually extensive, in that 10% to 50% of the chain mer units are crosslinked. Only heating to excessive temperature will cause severance of these crosslink bonds and polymer degradation. Thermoset polymer is generally harder and stronger than thermoplastics and has better dimensional stability. Thermoset may contain filler materials such as powder or fiber to provide improved strength and stiffness (Anonymous 3, 2009).