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MECHANICAL BEHAVIOUR OF POLYMER BASED BAMBOO COMPOSITE 1

IZZAT BIN NAZAR

Report submitted in partial fulfilment of the requirements

for the award of the degree of

Bachelor of Engineering in Manufacturing Engineering

Faculty of Manufacturing Engineering

UNIVERSITI MALAYSIA PAHANG

June 2016

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LIST OF SYMBOLS

W1	Initial weight of specimen g
W2	Specimen weight after N hours of water soaking, g
Wt	Weight of the specimen at the time, t
Wo	Weight of the initial specimen after drying

LIST OF ABBREVIATIONS

BSPP	Bamboo strips, polypropylene
CAN	Chemical Assisted Nature
CMT	Compression Moulding Technique
RMT	Roller Mill Technique
PP	Polypropylene
ASTM	American Society for Testing and Materials
UTM	Universal Testing Machine
DTP	Discretized turning point FE Finite element
BF	Bamboo Fiber
APS	Aminopropyltrimethoxy silane
GPS	Lycidoxypropyltrimethoxy silane
MPS	Methacryloxypropyltrimethoxy silane
PEG	Polyethylene glycol
BFRP	Bambo Fiber Reinforced Polypropylene
PLA	Polylatic acid
BFEC	Bamboo-fiber composite
BFcEc	Bamboo fiber cotton eco-composites
FRP	Fiber reinforced epoxy composites

FGC	Fiber length on the mechanical properties of green bamboo fiber reinforced composite
NaOH	Sodium Hydroxide
MAPP	Maleted polypropylene
BGRP	Bamboo-glass reinforced polypropylene
RTM	Resin Transfer Moulding
PE	Polyethylene
PS	Polystyrene
IFSS	Interfacial shear strength
PLC	Programmable Logic Controller

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ABSTRACT

Polymer consist of the long chain molecules constructed of atoms (such as carbon and hydrogen) in the various arrangements with the different elements in the forming of basic building block of a polymer chain. Besides that, natural fiber reinforced polymer composite has a huge affinity to replace the composite made up of synthetic fiber. This is primarily because of the advantages like light weight, non-toxic, non-abrasive, easy availability, low cost and biodegradable properties. Bamboo fiber (BF) materials have attracted broad attention as reinforcement polymer composites due to their environmental sustainability, mechanical properties and recyclability and they can be compared with glass fiber. The main aim of this research was to study the feasibility of using a bamboo natural fiber as reinforcement in the development of partially biodegradable green and environmentally friendly composite. The reinforcement was bamboo fiber (BF) and the polymer matrix was polypropylene (PP). The composites were prepared by means of hot press with different weight percentages (20, 30 and 40). And then, the developed bamboo fiber (BF) reinforced polypropylene (PP) composites were then tested for their mechanical properties. On the basis of experimental results showed that the bamboo fibers (bundles) had a sufficient specific strength, which is equivalent to that of conventional glass fibers. The tensile strength and modulus of PP based composites using hot press, it is found that 20% of bamboo fiber mixed PP is giving optimum mechanical properties compare to 30% and 40%. But, there are also have some problem in process, which is need to consider in suitable extraction method, fiber length, resin application, moisture content and composite preparation techniques. From the experiments results, it can be concluded that using more bamboo fiber, the specimen become more brittle. Using "Video Measurement System", it shows that the poor interfacial bonding generates partial spaces between the fiber and matrix material, hence resulting in a weak structure.

ABSTRAK

Polimer terdiri daripada molekul rantai panjang dibina daripada atom (seperti karbon dan hidrogen) dalam pelbagai urusan dengan unsur-unsur yang berbeza dalam membentuk blok binaan asas rantaian polimer. Selain itu, serat semula jadi bertetulang polimer komposit mempunyai pertalian yang besar untuk menggantikan komposit yang terdiri daripada serat sintetik. Ini adalah terutamanya kerana kelebihan seperti ringan, bukan toksik, bukan kasar, mudah tersedia, kos rendah dan sifat-sifat mesra alam. Serat buluh (BF) bahan-bahan telah menarik perhatian luas sebagai tetulang komposit polimer kerana kebolehannya mengekalkan alam semulajadi, sifat mekaniknya dan boleh dikitar semula dan ia juga setanding dengan gentian kaca. Tujuan utama kajian ini adalah untuk mengkaji kemungkinan menggunakan gentian semulajadi buluh sebagai tetulang dalam pembangunan komposit separa hijau dan mesra alam “biodegradable”. Tetulang adalah serat buluh (BF) dan matriks polimer adalah polypropylene (PP). Komposit telah disediakan melalui tekanan panas “hot press” dengan peratusan berat atau kuantiti yang berbeza (20, 30 dan 40). Kemudian, serat buluh (BF) bertetulang komposit polipropilena (PP) kemudiannya diuji untuk sifat-sifat mekanik mereka. Berdasarkan keputusan eksperimen menunjukkan bahawa serat buluh (BF) dalam bentuk “bundles” mempunyai kekuatan tertentu yang mencukupi, yang bersamaan dengan yang gentian kaca konvensional. Kekuatan tegangan dan modulus komposit berdasarkan PP menggunakan tekanan panas “hot press”, didapati bahawa 20% daripada gentian buluh bercampur PP memberi sifat-sifat mekanik optimum berbanding dengan 30% dan 40%. Tetapi, terdapat juga beberapa masalah dalam proses, yang perlu mengambil kira dalam kaedah sesuai pengekstrakan, panjang gentian, penggunaan resin, kandungan kelembapan dan teknik penyediaan komposit. Daripada keputusan eksperimen, dapat disimpulkan bahawa menggunakan lebih banyak serat buluh, spesimen menjadi lebih rapuh. Menggunakan "Sistem Pengukuran Video", ia menunjukkan bahawa ikatan antara muka yang lemah menjana ruang separa antara gentian dan bahan matriks, oleh itu menghasilkan struktur yang lemah.

CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

Bambusa or we recognize as bamboo in the botanical features a range of about 7 to 10 sub families of group and there are 1575 kind variety of species ranging from the type of wood to bamboo herbs. Each particular species of bamboo have different types of properties and qualities. Bamboo is easily approachable globally, 64% of the bamboo plantation came from Southeast Asia, 33% is grown in South America, and the rest come from Africa and Oceania because it takes only several months to regrow. However, production that using a bamboo naturally was rich with traditional elements and suitable for variety. Bamboo also as a great potential to be used as a substitute for solid wood, especially in manufacturing, design, and construction applications (Suhaily et al., 2013).

Figure 1.1: Bamboo plantations in China

Source: Suhaily et al., (2013)

In the last few years, bamboo is increasingly recognized as it has gone to natural fibers. Bamboo fibers or know as a natural glass fibers have high strength with respect to its weight. However, it is often brittle compared with other natural fibers, because the lining will cover the fibres. There are several papers and journals have been published on the study of the bamboo fiber reinforced composites using polymers, which is thermoplastic and thermoset (Okubo et al., 2004).

The most common reinforcement bamboo fiber used today is a matrix of thermoplastic polypropylene because the bamboo strips have a high cohesive strength of bamboo fiber extracted. Bamboo strips, polypropylene (BSPP) composites have a better characteristics that including high bending, acoustic characteristics and high sound good moisture which makes them suitable raw material and ideal to replace glass fibres currently used for the substrate that renowned automotive (Suhaily et al., 2013).

Besides that, the potential and importance of the bamboo used in thermoset composites is expected to have the same trend as thermoplastic composites. Bamboo fiber reinforced epoxy composites are subject to wear and friction environment to achieve widespread acceptance for use in many applications. The bamboo strips available epoxy composite materials attractive for use in the marine sector around the world has resulted in a bamboo boat hulls using vacuum bagging and compression moulding processes (Suhaily et al., 2013).

Furthermore, there are several methods to extract the bamboo fibres, for example by mechanical extraction, chemical extraction or combined the mechanical and chemical extraction. First, the mechanical extraction method can take the form of different procedures such as steam or heating steam explosion, retting, crushing, grinding and roll mill. These methods have been used to produce fiber for the application of bamboo fiber reinforced composites in a variety of industries. Second, chemical extraction procedures using alkali or acid retting, chemical methods, chemical assisted nature (CAN), or degumming to reduce or to remove fibres lower lignin content. These treatments also have side effects on other components of the microstructure of bamboo including pectin and hemicellulose. Lastly, a combination of mechanical and chemical extraction method is the compression moulding technique (CMT) and roller mill technique (RMT) commonly removes the fibres after chemical and alkali treatment (Zakikhani et al., 2014).

The manufacturing process to fabricate bamboo fibres is the most commonly used was introduced, for example hand lay-up technique, resin injection technique, hot press method, filament winding and pultrusion. While many variations on these techniques exist, this view gives a good indication of the possibility of withdrawal.

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