UNIVERSITI PUTRA MALAYSIA

MECHANICAL CHARACTERISATION OF SAWDUST AND CHIPWOOD-FILLED EPOXY COMPOSITE

NORHISHAM BIN SEYAJAH

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By

NORHISHAM BIN SEYAJAH

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Very grateful to ALLAH for
The blessing
To my family and everyone
Involved in my life,
Thank you…..

Abstract of thesis presented to the senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of master of science.

MECHANICAL CHARACTERISATION OF SAWDUST AND CHIPWOOD-FILLED EPOXY COMPOSITE

By

Norhisham Seyajah

February 2008

Chairman : Associate Professor Datin Napsiah Ismail, Ph.D

Faculty : Engineering

Natural fibre are increasingly being used as reinforcement in commercial thermoset due to their low cost and renewable nature. In this research the composite of epoxy with sawdust and chip wood untreated wood fibre content 14% by weight as a filled were studied and waste wood obtained from the timber industry.

The highest tensile strength valued for sawdust is 28.917 MPa and chip wood is 21.951 MPa, compare with epoxy if self is 16.307 MPa. Meanwhile the highest flexural strength values for sawdust is 0.468 MPa, and chip wood is 0.596 MPa, compare with epoxy it self is 0.645 MPa.

However in addition the good trend in elongation at break of epoxy composite with sawdust and chip wood due to the dispersion of the individual fibre as the fibre contents was different size in the matrix. It is also that some matrix materials adhere to the surface of the pull out fibre indicating a good bond and interfacial adhesion between the matrix and the fibre.

Further testing, using scanning electron microscopy (SEM) micrographs on tensile of sawdust epoxy composite showed very little fibre pull out and splitting, and for tensile of chip wood epoxy composite showed although there is a bigger contact surface between filler and matrix but the adhesion is no good. Meanwhile the flexural of sawdust epoxy composite showed the poor adhesion and there are a void around the sawdust particle, and for flexural of chip wood epoxy composite showed cavities clearly indicate the poor interfacial adhesion between the epoxy matrix polymer.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan bagi ijazah Master Sains

SIFAT-SIFAT MEKANIKAL BAGI HABUK KAYU DAN SERPIHAN KAYU-PENGISI EPOKSI KOMPOSIT

Oleh

NORHISHAM SEYAJAH

Februari 2008

Pengerusi : Professor Madya Datin Napsiah Ismail. PhD

Fakulti : Kejuruteraan

Penggunaan gentian semulajadi semangkin meningkat sebagai bahan penguat dalam komersial termoset disebabkan harganya yang rendah serta bahan ini boleh diperbaharui. Pada kajian ini epoksi komposit diperkuat dengan serbuk kayu dan serpihan kayu yang tidak dilakukan sebarang perawatan sebagai pengisi dimana kandungan gentian kayu sebanyak 14% mengikut berat dikaji, bahan sisa kayu ini diperolehi dari industri perkayuaan.

Kekuatan tensil untuk habuk kayu bernilai 28.917 MPa, manakala untuk serpihan kayu pula bernilai 21.951 MPa, jika dibandingkan dengan epoksi komposit tanpa gentian hanya 16.307 MPa. Pada masa yang sama kekuatan fleksural untuk habuk kayu pula bernilai 0.468 MPa, dan untuk serpihan kayu pula bernilai 0.596 MPa, jika dibandingkan dengan epoksi komposit tanpa gentian bernilai 0.645 MPa.

Walaubagaimanapun sebagai tambahan pemanjangan pada takat putus untuk epoksi komposit pengisi dengan sebuk kayu dan serpihan kayu menunjukkan petanda arah

yang baik disebabkan penyerakkan gentian secara individu sebagai kandungan gentian pada ukuran yang berbeza didalam matriks. Pada masa yang sama juga ada sebahagian matriks yang masih melekat pada permukaan gentian yang tercabut keluar, ini menunjukkan ikatan yang baik dan juga lekatan diantara permukaan yang menjadi sempadan bersama antara dua iaitu matriks dan gentian.

Kajian seterusnya, menggunakan scanning electron microscope (SEM) micrographs pada tensil serbuk kayu epoksi komposit menunjukkan sedikit gentian tertarik keluar serta merekah, manakala pada tensil serpihan kayu epoksi komposit pula menujukkan walaupun terdapat permukaan cantuman yang besar diantara pengisi dengan matrik, lekatannya kurang baik kerana terdapat retakan serta ruang kosong diantar dua permukaan. Dalam pada masa yang sama untuk fleksural pada serbuk kayu epoksi komposit menunjukkan serbuk kayu yang tidak dirawat memberikan kesan lekatan yang kurang baik kerana terdapat rongga disekeliling partikel serbuk kayu, manakala untuk fleksural pada serpihan kayu epoksi komposit menunjukkan dengan jelas terdapat rongga dimana menandakan kelemahan antara muka diantara epoksi matriks polimer.

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I certify that an Examination Committee met on to conduct the final examination of Norhisham Bin Seyajah on his Master of Science thesis entitled "Investigation on the mechanical characteristics of sawdust and chip wood filled epoxy" in accordance with University Putra Malaysia (Higher Degree) Act 1980 and Universiti Putra Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the (Name of relevant degree).

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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Date: 10 July 2008

DECLARATION

I declare that the thesis is my original work expect for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

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NORHISHAM BIN SEYAJAH

Date: 26 February 2008

TABLE OF CONTENTS

List of Table

List of Figures

LIST OF ABBREVIATIONS

T_g	Glass transition temperature
WPCs’	Wood/plastic composites
PAN	Polyacrylonitrile
PET	Polyethyleneterephthalate
PTFE	Polytetrafluoroethylene
CVD	Chemical vapor deposition
UV	Ultraviolet
DGEBA	Diglycidyl ether of bisphenol A
TGNDA	Tetraglycidyl methylenedianiline
DDS	Diaminodiphenyl Sulfone
BF_3	Boron Trifluoride Amine Complex
PVC	Polyvinyl chloride
PE	polyethylene
FPL	Forest Products Laboratory
MC	Moisture contents
ASTM	American Society for Testing and Materials
SW	Saw Dust
CW	Chip Wood
ANOVA	Analysis of Variance
KN	Kilo Newton
GRP	Glass Fiber Reinforced Plastic
MOR	Modulus of rupture
MOE	Modulus of elasticity
SPSS	Statical Package for Sosial Ssiences
HSD	Honestly significant difference
LSD	Least significant difference
SD	Standard Division

CHAPTER 1

INTRODUCTION

1.1 Background

A composite material is one of the fastest growing industries with USA being the major consumer of composite materials. The global consumption of composite is now around two million tones annually and grow at the rate of 10 percent every year (Parasad, 1996). Studied by Susan *et. al., (*2004) composites containing recycled plastics and wood fiber offer an interesting combination of properties, as well as lower cost than competitive materials, especially those based on synthetic fibers. Historically, most of these used wood flour to produce filled plastics. The wood flour decreased the cost, but was not usually intended to improve the performance in any substantial way.

A composite, as its name suggests, is made by combining two or dissimilar materials in such a way that the resultant material is endowed with properties superior to any of its parental ones. The ancients knew that when they made alloys of metal they often got good result (Parasad, 1996). Like some of the materials, example by melting together copper and tin they made bronze, the earliest know alloy. Bronze had qualities superior to its parent metals neither of which could be identified once the alloy was formed. Nevertheless, they remain strongly bonded together while maintaining an interface between on another and act mutually to give a much-improved performance.

The increase and importance of product development in the market, composite materials proven as the effective materials can reduce the manufacturing cost and increase of the product quality. The polymers composite are not only displacing conventional engineering materials in many of their applications but also creating latest application unique to the end user. Nowadays, composite are often the material of choice of engineering for a variety of reason, including lightweight, high stiffness, high strength, low thermal expansion, corrosion resistance, and long fatigue life. In nature the example are a coconut palm, cellulose fiber in lignin matrix (wood), collagen fibers in an apatite bone and others.

In recent years, interest in the development of new composite materials derived from wood fibre and thermoplastic polymer matrices has grown markedly .Today the use of composite materials in all kind of structure is increasing rapidly especially in aviation and all industry. Aviation composite technology has advanced to the point where it is strong enough to be applied in primary and secondary structure. New development in materials technologies have had made it possible to design and build wood composite product that can perform better and operate more efficiently. This is where the use of composite materials has directly enhance the capability of commercial and wood composite in term of weight saving, strength and maneuverability (Jozsef,1982).

Today, plastic goods are getting more and more interest suitable to their multipurpose applications. However, disadvantages of the plastic turn up when they are essential to admit high forces or be stiffer. The trendy inorganic reinforcing component, such as glass fibres is extremely expensive therefore, one possible

option to reduce the composite production cost is to use organic wood fibres because of their abundancy, favourable cost and high stiffness. In wood industries such as the furniture industry or paper industry, a great amount of wood flakes and wood flours in the form of sawdust are always found as wastes. These unused materials are usually applied as a fuel source or for the manufacture of plywood' Since of high accessibility and low cost of the sawdust, it can be more flexible and significant by compounding the sawdust with plastics in order to improve plastic properties, for example, high strength and easy processing that are better than wood or plastics. In the related literature, it has been reported that most polymer composites involve fibre reinforcement, for instance, bamboo fibres (Chen *et al.,* 1998), fibres from oil palm empty fruit bunch (Rozman *et al*., 2003), Bamboo fibre filled natural rubber composites (Hanif I. *et. al.,* 2002), and Mechanical performance of woodfibre (Krishnan Jayaraman and Debes Bhattacharyya 2004). Ash from timber waste as cement replacement material (Elinwa and Mahmood (2002).

Wood known a valuable natural composite material with a very large utilization as solid wood or in wood-based composite materials. Its qualities but also its defects (dimensional instability, susceptibility to biological attack, anisotropy) are due to its complex structure.

Wood is a unique material. It stand alone in many characteristics when compare with man-made such as steel, concrete, stone, brick, and most synthetics. Its is already complex nature is further modified when used in products ranging from large glued-laminated members spanning hundreds of feet to small items such as a sheet of paper or a toy (Jozsef,1982).