



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**EFFECTS OF MALEATED POLYPROPYLENE (MAPP) ON THE
MECHANICAL PROPERTIES OF RUBBER SEED SHELL
POWDER (RSSP)/ POLYPROPYLENE (PP) COMPOSITES**

The report submitted in accordance with the requirements of the Universiti Teknikal
Malaysia Melaka for the Bachelor Degree of Manufacturing Engineering (Engineering
Materials) with Honours

by

RAJA MANISA BINTI RAJA MAMAT

FACULTY OF MANUFACTURING ENGINEERING

2009



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PSM

JUDUL: EFFECTS OF MAPP ADDITION ON THE MECHANICAL PROPERTIES OF RSSP/
PP COMPOSITES

SESI PENGAJIAN: Semester 2 (2008/2009)

Saya RAJA MANISA BINTI RAJA MAMAT

mengaku membenarkan laporan PSM / tesis (Sarjana/Doktor Falsafah) ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM / tesis adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM / tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. *Sila tandakan (✓)

SULIT

(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia yang termaktub di dalam AKTA RAHSIA RASMI 1972)

TERHAD

(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

TIDAK TERHAD

ka

(TANDATANGAN PENULIS)

Alamat Tetap:

LOT 5585, Kampung Tebakang,
Bukit Payong, 21400, Marang,
Terengganu Darul Iman

Tarikh: 16/05/2009

P. L. S. Anand

(TANDATANGAN PENYELIA)

Cop Rasmi:

PROF. MADYA DR. T. JOSEPH SAHAYA ANAND

Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka
Kampung Berkun, 75450 Melaka
Ayer Keroh, 75450 Melaka

Tarikh: 16/05/2009

* Jika laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT atau TERHAD.



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Karung Berkunci 1200, Ayer Keroh, 75450 Melaka

Tel : 06-233 2421, Faks : 06 233 2414

Email : fkp@kutkm.edu.my

FAKULTI KEJURUTERAAN PEMBUATAN

Rujukan Kami (Our Ref) :
Rujukan Tuan (Your Ref):

15 Mei 2009

Pustakawan
Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM)
Taman Tasik Utama, Hang Tuah Jaya,
Ayer Keroh, 75450, Melaka

Saudara,

PENKELASAN LAPORAN PSM SEBAGAI SULIT/TERHAD
- LAPORAN PSM SARJANA MUDA KEJURUTERAAN PEMBUATAN (BAHAN
KEJURUTERAAN): RAJA MANISA BT RAJA MAMAT
TAJUK: EFFECTS OF MAPP ADDITION ON THE MECHANICAL PROPERTIES OF
RSSP/ PP COMPOSITES

Sukacita dimaklumkan bahawa tesis yang tersebut di atas bertajuk "EFFECTS OF MAPP ADDITION ON THE MECHANICAL PROPERTIES OF RSSP/ PP COMPOSITES" mohon dikelaskan sebagai terhad untuk tempoh lima (5) tahun dari tarikh surat ini memandangkan ia mempunyai nilai dan potensi untuk dikomersialkan di masa hadapan.

Sekian dimaklumkan. Terima kasih.

"BERKHIDMAT UNTUK NEGARA KERANA ALLAH"

Yang benar,

9-2-11 Anand


.....
PROF. MADYA THANGARAJ JOSEPH SAHAYA ANAND

Pensyarah,
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka (UTeM)
Karung berkunci 1200, Ayer Keroh,
75450, Melaka

PROF. MADYA DR. T. JOSEPH SAHAYA ANAND
Professor Madya,
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka
Karung Berkunci 1200, Hang Tuah Jaya,
Ayer Keroh, 75450 Melaka.

DECLARATION

I hereby declare that this report entitled “**EFFECTS OF MALEATED PROPYLENE (MAPP) ADDITION ON THE MECHANICAL PROPERTIES OF RUBBER SEED SHELL POWDER (RSSP)/ POLYPROPYLENE (PP) COMPOSITES**” is the result of my own research except as cited in the references.

Signature : 
Author's Name : Raja Manisa Bt Raja Mamat
Date : 14th May 2009

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Engineering Materials) with Honours. The member of the supervisory committee is as follow:

(Signature of Supervisor)

T. J. Anand

.....
(Official Stamp of Supervisor)

PROF. MADYA DR. T. JOSEPH SAHAYA ANAND
Professor
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka
Karung Berkunci 1200, Hang Tuah Jaya,
Ayer Keroh, 75450 Melaka.

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Engineering Materials) with Honours. The member of the supervisory committee is as follow:

(Signature of Principal Supervisor)

T. J. Anand

.....

(Official Stamp of Principal Supervisor)

PROF. MADYA DR. T. JOSEPH SAHAYA ANAND
Profesor Madya
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka
Karung Berkunci 1200, Hang Tuah Jaya,
Ayer Keroh, 75450 Melaka.

ABSTRACT

The main purpose of doing this project is to study the effects of maleated polypropylene (MAPP) addition to the properties of rubber seed shell powder (RSSP)/ Polypropylene (PP) composites fabrication by using mechanical testing methods. For sample preparation, firstly the rubber seed shell is separated from its seed then cleaned by water. After being dried, this rubber seed shell is pulverized by rotor mills. This pulverization process is carried out to transform the shell into the powder form. This process is conducted at Material Laboratory, UTeM. Four different compositions of MAPP concentration are used which are 0 wt %, 3 wt %, 7 wt % and 9 wt %. A mould with dimension 400 mm x 400 mm x 3 mm is used to fabricate the composite. The sample fabrication is done through mixing, extrusion, crushing and hot pressing process. After that, the testings are done in order to assess the mechanical properties of composites. The test methods used are tensile test, flexural and impact test. From these testing, it can be concluded that the strength of composite is increased when the MAPP is added, the optimum weight percentage of MAPP is 3 wt % for better mechanical properties.

ABSTRAK

Tujuan utama projek ini dijalankan adalah untuk mengkaji kesan penambahan “maleated polypropylene (MAPP)” terhadap sifat-sifat mekanikal komposit yang dihasilkan daripada serbuk cangkerang biji getah dan polipropilin. Kesan-kesan ini dikaji menerusi kaedah penyiasatan mekanikal. Proses penyediaan sampel dimulakan dengan mengasingkan cangkerang biji getah daripada bijinya kemudian dibersihkan menggunakan air. Selepas dikeringkan, cangkerang biji getah ini akan melalui proses penghancuran menggunakan “rotor mills”. Proses penghancuran ini dijalankan bertujuan untuk menukarkan cangkerang kepada bentuk serbuk. Semua proses ini dijalankan di dalam Makmal Bahan, UTeM. Empat komposisi komposit dengan peratusan berat MAPP yang berbeza digunakan iaitu 0 wt %, 3 wt %, 7 wt % dan 9wt %. Satu acuan berukuran 400 mm x 400 mm x 3 mm digunakan untuk menghasilkan komposit ini. Penghasilan sampel dilakukan menerusi proses pecampuran, penyemperitan, penghancuran semula dan pemanasan tekanan. Selepas itu, ujikaji-ujikaji dijalankan untuk mengkaji sifat-sifat mekanikal komposit yang terhasil. Kedah-kaedah ujikaji in termasuklah “tensile test, flexural test dan impact test”. Menerusi ujikaji, sifat kekuatan komposit meningkat apabila ditambahkan dengan MAPP dan sifat mekanikal terbaik dicapai pada peratusan MAPP optimum 3 wt %.

DEDICATION

For all advices and encouragement, this study is gratefully dedicated to my supervisor, lecturers, my family, friends and individuals that involves in this study. Thank you very much for continuous support and guidance.

ACKNOWLEDGEMENT

In the name of Allah, The Beneficent, the Merciful, thank for his guidance to accomplish this project. I would like to express my profound appreciation to all persons that involve, lend a hand and contribute idea in accomplish my final year project. Endless appreciation and gratitude to my supervisor, Prof. Madya Dr. Thangaraj Joseph Sahaya Anand and my ex-supervisor, Mr. Edeerozey bin Abd. Manaf for their advices, guidances and supporting ideas for my PSM I and II. Also thanks to my examiner, Mr. Zulkifli Rosli. I truly relished the opportunity given in working with them. I would like express special thanks to all my friends whose also helping me to find out more information about this project. Last but not least, my appreciation also to all technicians that guide me during all process and information related to this project. Finally, my sincere appreciation is dedicated to my parents and family for their fully support and encouragement either finance support or moral support. Thank you.

TABLE OF CONTENT

Abstract	i
Abstrak	ii
Dedication	iii
Acknowledgement	iv
Table of Content	v
List of Tables	x
List of Figures	xii
List of Abbreviations	xv
1. INTRODUCTION	
1.1 Background	1
1.2 Problem Statement	2
1.3 Research Scope	3
1.4 Research Objectives	3
2. LITERATURE REVIEW	
2.1 Composite	4
2.1.1 Introduction to Composite	4
2.1.2 Definition and Classification of Composite	5
2.1.3 Basic Constituents of Composite	7
2.1.3.1 Matrix	7
2.1.3.2 Reinforcement	8
2.1.4 Factors Influences the Properties of Composite	8
2.1.5 Benefits of Composite	8

2.1.6	Applications of Composite	9
2.2	Polymer Matrix Composite (PMC)	10
2.2.1	Thermoplastic	11
2.2.1.1	Structure of Thermoplastic Composite	11
2.2.1.2	Polypropylene	12
2.3	Natural Fibers	13
2.3.1	Introduction of Rubber Seed Shell Powder	15
2.3.1.1	History of Rubber Tree	15
2.3.1.2	Rubber Seed Shell	16
2.4	Additives	17
2.4.1	Coupling Agent	17
2.4.1.1	Maleated Polypropylene (MAPP)	18
3.	MATERIALS AND METHODOLOGY	
3.1	Introduction	19
3.2	Materials	19
3.2.1.	Rubber Seed Shell (RSS)	19
3.2.2	Polypropylene (PP)	20
3.2.3	Maleated Polypropylene (MAPP)	21
3.2.4	Mild Steel	21
3.3	Methodology	21
3.3.1	Preparation of RSSP	22
3.3.2	Mould Fabrication	24
3.3.2.1	Mould Design	25
3.3.3	Composite Fabrication	25
3.3.4	Testing Analysis	27
3.3.4.1	Tensile Test	27

3.3.4.2	Flexural Test	29
3.3.4.3	Pendulum Impact Test	32
3.3.5	Additional Analysis	36
3.3.5.1	Microstructure Observation	36
4.	RESULTS	
4.1	Introduction	39
4.2	Tensile Test	39
4.2.1	Tensile Strength	40
4.2.2	Young's Modulus	40
4.2.3	Elongation to Break	41
4.3	Flexural Test	42
4.3.1	Flexural Strength	42
4.3.2	Flexural Modulus	43
4.4	Impact Test	45
4.4.1	Energy Absorbed	46
4.4.2	Impact Strength	46
5.	DISCUSSION AND ANALYSIS	
5.1	Introduction	49
5.2	Test Analysis	49
5.2.1	Tensile Test	49
5.2.1.1	Young's Modulus	50
5.2.1.2	Elongation to Break	51
5.2.1.3	Tensile Strength	52
5.2.2	Flexural Test	53
5.2.2.1	Flexural Strength	53

5.2.2.2	Flexural Modulus	54
5.2.3	Impact Test	55
5.2.3.1	Impact Strength	55
5.3	Summary of Analysis	56
5.4	Difficulties and Problems Faced	57
5.4.1	Difficulties during Raw Material Preparation	57
5.4.2	Difficulties during Fabrication of RSSP/ PP Composites	58
5.4.3	Difficulties during Mechanical Testing	59
6.	CONCLUSIONS AND RECOMMENDATIONS	60
	REFERENCES	62
	APPENDICES	
	Gantt Chart	

LIST OF TABLES

Table 2.1.2	Mechanical Characteristic between Three Matrices	5
Table 2.1.6	Applications of Composites	9
Table 2.2.1	Differences between Thermoplastic and Thermosetting	11
Table 2.2.1.2	Properties of Polypropylene	13
Table 2.3	Advantages and Disadvantages of Using Natural Fibers	14
Table 3.3.1	Specification of Variable Speed Rotor Mills	24
Table 3.3.3	Total Samples for Mechanical Testing	27
Table 3.3.4.1	Dimension for Tensile Specimen (ASTM D638)	29
Table 3.3.4.2	Dimension for Flexural Specimen (ASTM D 790)	32
Table 3.3.4.3 (a)	Components of Pendulum Impact Tester	33
Table 3.3.4.3 (b)	Dimension for Impact Specimen (ASTM D265)	36
Table 4.2.1	Tensile Strength of RSSP/ PP Composites	40
Table 4.2.2	Young's Modulus of RSSP/ PP Composites	41
Table 4.2.3	Elongation to Break of RSSP/ PP Composites	41
Table 4.3.1	Flexural Strength of RSSP/ PP Composites	43
Table 4.3.2	Flexural Modulus of RSSP/ PP Composites	45
Table 4.4.1 (a)	Energy Absorbed	46
Table 4.4.1 (b)	Impact Strength	48

LIST OF FIGURES

Figure 2.1.2 (a)	Classification of Composite Materials	6
Figure 2.1.2 (b)	Examples of Composite Reinforcement Type	7
Figure 2.2.1.1	Structure of Thermoplastic	12
Figure 2.2.1.2	Structure of Polypropylene (PP)	12
Figure 2.3.1.1	Rubber Tree	15
Figure 3.2.1	Rubber Seed Shell	20
Figure 3.2.2	Polypropylene Granules	20
Figure 3.2.3	MAPP Granules	21
Figure 3.3.1 (a)	RSS after Breaking Process	22
Figure 3.3.1 (b)	RSS after Crushed	22
Figure 3.3.1 (c)	RSS after Milled/ Pulverized	23
Figure 3.3.1 (d)	Variable Speed Rotor Mill	23
Figure 3.3.2.1	Dimension of Mould	25
Figure 3.3.3 (a)	Mixer Machine	36
Figure 3.3.3 (b)	Hot Press Machine	36
Figure 3.3.4.1 (a)	Schematic Diagram of Tensile Test	28
Figure 3.3.4.1 (b)	Stress- Strain Curve	28
Figure 3.3.4.1 (c)	ASTM D638 Type I Specimen	29
Figure 3.3.4.1 (d)	Universal Testing Machine (UTM)	30
Figure 3.3.4.2 (a)	Schematic Diagram of Flexural Test	31
Figure 3.3.4.2 (b)	3 Point Bending Test	31
Figure 3.3.4.3 (a)	Pendulum Impact Test (Izod Test)	33
Figure 3.3.4.3 (b)	Angle and Depth of Notch	34

Figure 3.3.4.3 (c)	Schematic Diagram of Izod Test	35
Figure 3.3.4.3 (d)	Position of Izod Test Specimen	35
Figure 3.3.5	Schematic Diagram of SEM	37
Figure 3.3.6	Process Flow of Sample Preparation	38
Figure 4.2 (a)	Specimen before Tensile Testing	40
Figure 4.2 (b)	Specimen after Tensile Testing	40
Figure 4.3 (a)	Specimen before Flexural Testing	42
Figure 4.3 (b)	Specimen after Flexural Testing	42
Figure 4.4 (a)	Specimen before Impact Testing	46
Figure 4.4 (b)	Specimen after Impact Testing	46
Figure 5.2.1.1	Young's Modulus at Difference Concentration of MAPP	50
Figure 5.2.1.2	Elongation to Break at Difference Concentration of MAPP	51
Figure 5.2.1.3	Tensile Strength at Difference Concentration of MAPP	52
Figure 5.2.2.1	Flexural Strength at Difference Concentration of MAPP	53
Figure 5.2.2.2	Flexural Modulus at Difference Concentration of MAPP	54
Figure 5.2.3.1	Impact Strength at Difference Concentration of MAPP	55
Figure 5.3	Normalized Properties at Difference Concentration of MAPP	57
Figure 5.4.2	Poor Homogeneity and Voids	59

LIST OF ABBREVIATIONS

ASTM	-	American Society Testing Material
CA	-	Coupling Agent
CMC	-	Ceramic Matrix Composite
GPa	-	Giga Pascal
MA	-	Maleic Anhydride
MAPP	-	Maleated Polypropylene
MMC	-	Metal Matrix Composite
MPa	-	Mega Pascal
PMC	-	Polymer Matrix Composite
PP	-	Polypropylene
RSS	-	Rubber Seed Shell
RSSP	-	Rubber Seed Shell Powder
SEM	-	Scanning Electron Microscope
UTeM	-	Universiti Teknikal Malaysia Melaka
°C	-	Celsius Degree
T _g	-	Glass Transition Temperature
Wt %	-	Weight Fraction

CHAPTER 1

INTRODUCTION

1.1 Background

Technological development coupled with consumer expectations continues to increase demands on the Earth's resources, leading to major issues relating to material availability and environmentally sustainability. Recently, a general consensus with regard to the large contribution made by humans to the current phase of global warming has been reached. This will add further emphasis to the awareness of the need to act in an environmentally responsible manner. This awareness also led to increase interest in material derived from more sustainable resources that can be processed with lower energy consumption requirements as well as recyclable materials including those from which energy can be recovered, as found within spectrum of natural fiber composites.

One major area of development over the past decade has been in the use of compression molded natural fiber reinforced thermoplastics panels that have been widely adopted in the European automotive industry for parts such as door panels, dashboards and others. Since 2000, the steady growth of the use of natural fibers in cars has been observed increasing in Germany. For example, from 10 000 tonnes in 2000, it is increase to 19 000 tonnes in 2005 as summarized by Preusser, S. (2006). Indeed, much research effort has focused on improving mechanical performance of natural fiber thermoplastic composite which could enable extension of their application. Much of the research has been aimed at the improvement of interfacial strength for which a range of fiber treatments and coupling agents have been assessed. Pickering and Ji (2004) said that the most successful in terms of mechanical benefits along with the ease of use has been

obtained with maleated polypropylene (MAPP) as a coupling agent, giving strength and stiffness improvement of greater than 100% compared with uncoupled composites.

In this research, the effect of compatibilizer on the polymer composites which contains the composition of polypropylene and rubber seed shell powder (RSSP) will be investigated and analyzed, mainly on their mechanical properties. Meanwhile, maleated polypropylene (MAPP) is used as compatibilizer. Through this research, MAPP is used as a coupling agent for the PP and RSSP which is derived from rubber seed shell. Different sets of composites panels are prepared starting with powdering the rubber seed shell then mixed together with PP then MAPP is added at various concentrations (different weight percentage, wt %) during extrusion. The composite is then subsequently molded with hot press under specified temperature and pressure for the test specimen preparation. The effects of the MAPP addition on the mechanical properties such as tensile, flexural and impact strength are then observed.

1.2 Problem Statement

This research is justified by the importance to create environmentally friendly materials. Even though, a few researches about natural fibers have been undertaken by previous researcher, there is almost none research is done on rubber seed shell (RSS) polymer composites. The common research only focuses on another natural fiber such as jute and kenaf. Even if related to the rubber, normally research is done through natural rubber, rubber seed or rubber leaf. Through this project, the effects of MAPP addition on this type of composites (RSSP/ PP composites) will be studied. Besides, the utilization of RSSP as filler will also add value to the rubber seed shell (RSS) which is currently treated as agricultural waste.

1.3 Research Scopes

These composites are fabricated by using hot press molding technique. Tensile, impact, flexural and others test are carried out to determine the mechanical properties of composites when MAPP addition is added into these composites.

1.4 Research Objectives

The objectives of this thesis are:

- (a) To fabricate the RSSP/ PP composites.
- (b) To study the effects of the MAPP addition to the properties of the RSSP/PP composites.
- (c) To study the mechanical properties of RSSP/PP composites by several testing methods.

CHAPTER 2

LITERATURE REVIEW

2.1 Composite

Composite can be defined as a material in which two or more materials (matrix and filler) are binds together to form a new material with new properties.

2.1.1 Introduction to Composite

Composite materials are the most advanced and adaptable engineering materials. A composite is a heterogeneous material created by the synthetic assembly of two or more components constituting reinforcing matrix and a compatible matrix in order to obtain specific characteristics and properties as stated by Lugin G (1982). The matrix may be metallic, ceramic or polymeric in origin. The matrix gives a composite its shape, surface appearance, environment tolerance and overall durability while the fibrous reinforcement carries most of the structural loads, thus giving macroscopic stiffness and strength. It is the behavior and the characteristics of the interface that generally control the properties of a composite. Development of advanced composite materials having superior mechanical properties opened new horizons in the engineering field. Advantages such as corrosion resistance, electrical insulation, reduction in tooling and assembly costs, low thermal expansion, higher stiffness and strength, fatigue resistance, such as greater stiffness at lower weight than metal have made the polymer composites widely acceptable in structural applications. However, the disadvantages of composite

materials cannot be ignored. Their complex nature, lack of experience of designers, little knowledge of materials database and difficulty in manufacturing are barriers to large-scale use of composites.

2.1.2 Definition and Classification of Composite

According to the Encarta Dictionary, composite in term of material science is something made from different parts. Composite also defined as a mixture of two or more distinct constituents or phases. However, according to F.L Matthews and R.D Rawlings (1999), three certain criteria need to be considered to have a full definition of composite. The first is the both constituents should be present in an acceptable composition. Secondly, the properties of both constituents are different as well as composite properties. Lastly, composite is a mixed of materials to produce a new material. Then, this is a true composite material.

Composite are classified by various criteria according to convenient of the industry. Common classification is by differentiating the type of matrix. The most common designations based on matrix type are Polymer Matrix Composite (PMC), Ceramic Matrix Composite (CMC) and Metal Matrix Composite (MMC). **Table 2.1.2** lists the some mechanical characteristics between those three matrices.

Table 2.1.2: Mechanical Characteristics between Three Matrices.

Type of Matrix	Designation	Matrix Properties			Effective Reinforcement
		Strength (msi)	Stiffness (ksi)	Ductility	
Polymer	PMC	Low (0.2-0.5)	Low (0.5-5)	Low (< 2%)	Continuous fiber
Metal	MMC	Moderate (6-16)	High (10-150)	High (20 %)	Continuous and discontinuous fiber
Ceramic	CMC	High (20-80)	High (20-80)	Low (< 1%)	Discontinuous fiber/ Whisker/ Particulate

Composites can be classified based on the form of their structural components which are fibrous (composed of fibers in a matrix), laminar (composed of layers of materials, and particulate (composed of particle in a matrix). The particulate class can be further subdivided into flake and skeletal. In general, the reinforcing agents can be fibrous, powdered, spherical, crystalline or whiskered and either an organic, inorganic, metallic or ceramic material. The classification of composite can be summarized as **Figure 2.1.2 (a)** and **Figure 2.1.2 (b)**.

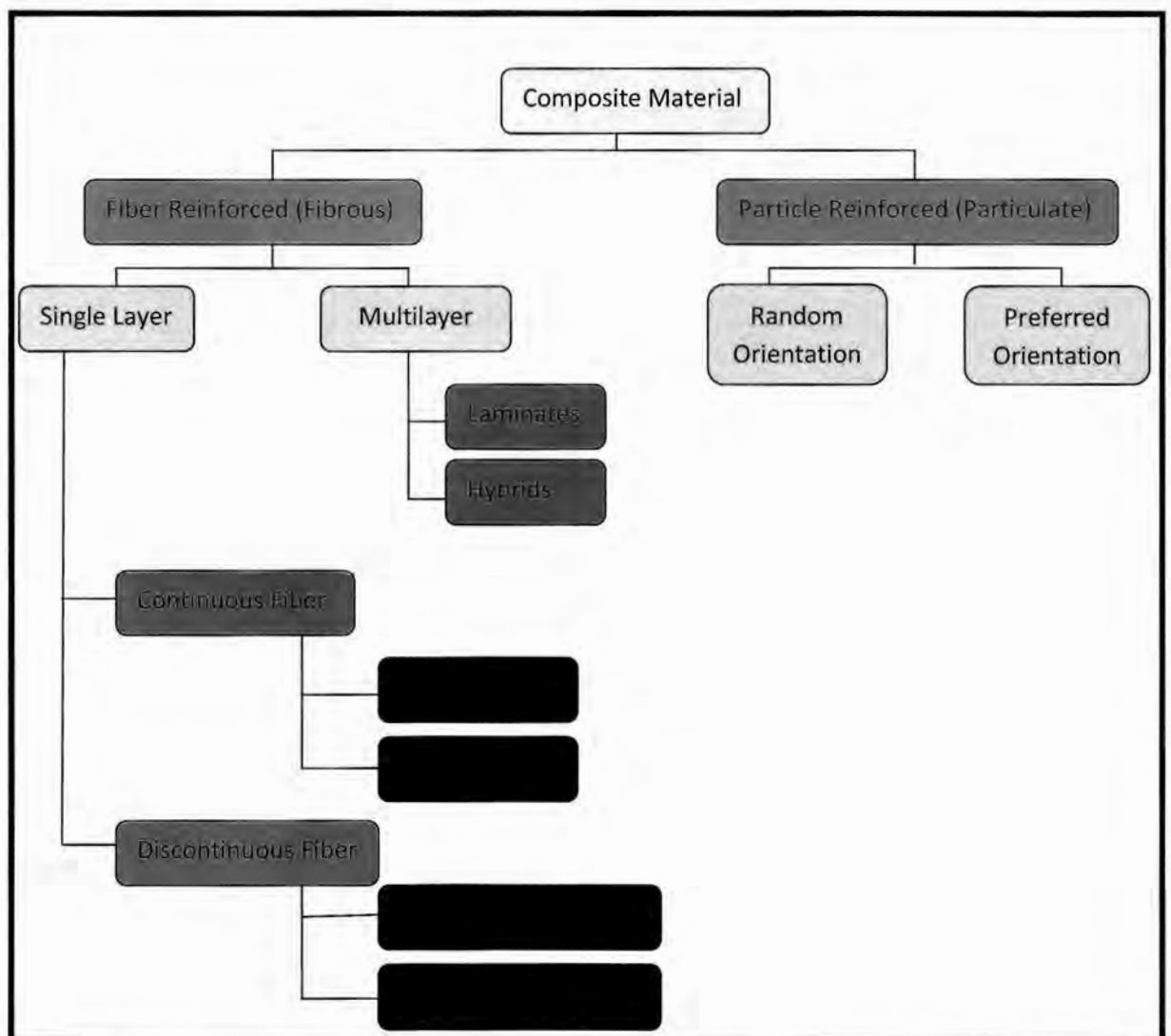


Figure 2.1.2 (a): Classification of Composite Materials. Source: Matthews and Rawlings (1999)