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MECHANICAL AND MORPHOLOGICAL PROPERTIES OF RICE HUSK-FILLED POLYPROPYLENE COMPOSITIES WITH STRUKTOL COMPATIBILISER

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By

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Chairman : Professor Mohd Sapuan Salit, PhD
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Development of new bio-based composites from renewable resources is getting wide attention from researchers due to environmental issue caused by traditional composites. Rice husk is a new potential renewable source of fillers for bio-composites to produce green products. Rice husk is the outer sheath surrounding rice grains during their growth. The aim of this work is to systematically review the parameters that affect the rice husk –polymeric composites in order to enhance their usage in various sustainable designs and applications. The main objectives of the work are to investigate the effect of filler loading on mechanical properties rice husk polypropylene composites and the effect morphological and performance deterioration of rice husk-polypropylene composites due to various liquid uptakes. Basically the main problem statement is to achieve a good combination of properties and processability at a moderate cost. Therefore, more efficient utilization of rice husk is urgently needed. One of the efforts is to produce value-added products such as rice husk polymer composites from these important bio-resources, several factors that influence and affects the properties of the composites need to be considered. Thus the optimum formulation of the polymer composite will be investigated. The combination of hydrophilic rice husk and hydrophobic polypropylene was caused poor interfacial bonding between fibre and matrix. Thus, additive agent struktol is used to improve the bonding between fibre and matrix. Five levels of filler loading (35, 40, 45, 50 and 55 wt%) were designed. All of the tensile strength, Young's modulus, Flexural strength, flexural modulus and impact strength properties were carried out. The results showed that 50 wt% filler-loaded composites had optimum tensile strength, flexural strength and flexural modulus whereas the 35 wt% of filler loading case was the best regarding Young's modulus, flexural strength, flexural modulus and impact strength. Furthermore, the scanning electron microscope results demonstrate that as filler loading increases, more voids and fiber pull-out occu

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Sains

SIFAT MEKANIKAL KOMPOSIT POLIPROPILENA TERISI SEKAM PADI DENGAN STRUKTOL

Oleh

NOR ATIRAH MOHD ARIDI

December 2016

Pengerusi : Professor Mohd Sapuan Salit, PhD
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Pembangunan komposit berasaskan bio baru dari sumber yang boleh diperbaharui semakin perhatian ramai daripada penyelidik disebabkan isu alam sekitar yang disebabkan oleh komposit tradisional. Sekam padi adalah sumber yang boleh diperbaharui baru yang berpotensi pengisi untuk bio-komposit untuk menghasilkan produk hijau. Sekam padi adalah sarung luar sekitar beras semasa pertumbuhan mereka. Tujuan karya ini adalah untuk mengkaji secara sistematik parameter yang memberi kesan kepada sekam padi komposit -polymeric bagi meningkatkan penggunaannya dalam pelbagai reka bentuk dan aplikasi mampan. Objektif utama kerja ini adalah untuk mengkaji kesan pembebanan pengisi ke atas hartanah beras komposit sekam polipropelina mekanikal dan kesan morfologi dan kemerosotan prestasi beras komposit sekam-polipropelina kerana pelbagai pengambilan cecair. Pada dasarnya pernyataan masalah utama ialah untuk mencapai kombinasi yang baik sifat dan processability pada kos yang sederhana. Oleh itu, penggunaan yang lebih cekap sekam padi amat diperlukan. Salah satu usaha adalah untuk menghasilkan produk nilai tambah seperti komposit polimer sekam padi dari ini penting bio-sumber, beberapa faktor yang mempengaruhi dan memberi kesan kepada sifat-sifat komposit perlu dipertimbangkan. Oleh itu penggubalan optimum komposit polimer akan disiasat. Gabungan sekam padi hidrofilik dan hidrofobik polipropelina disebabkan ikatan antara muka yang lemah antara gentian dan matriks. Oleh itu, bahan tambahan struktol ejen digunakan untuk meningkatkan ikatan antara gentian dan matriks. Lima tahap pengisi (35,40,45,50 dan 55% berat) telah direka. Semua kekuatan tegangan, modulus Young, kekuatan lenturan, lenturan modulus dan kesan kekuatan hartanah telah dijalankan. Hasil kajian menunjukkan bahawa 50% berat komposit pengisi dimuatkan mempunyai kekuatan tegangan yang optimum, kekuatan lenturan dan modulus lenturan manakala 35% berat kes pembebanan pengisi adalah yang terbaik mengenai modulus Young, kekuatan lenturan, lenturan modulus dan kesan kekuatan. Tambahan pula, keputusan imbasan mikroskop elektron menunjukkan bahawa apabila pengisi bertambah, komposit akan menjadi lebih lompang dan tarik-keluar gentian berlaku.

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I certify that a Thesis Examination Committee has met on 3 April 2017 to conduct the final examination of Nor Atirah Mohd Aridi on her thesis entitled "Mechanical And Morphological Properties Of Rice Husk-Filled Polypropylene Composities With Struktol Compatibiliser" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science

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LIST OF ABBREVIATIONS

RH	Rice husk
PP	Polypropylene
SEM	Scanning Electron Microscope
wt %	Unit percentage (Filler Loading)
FAO	Food and Agricultural Organisation
MAPP	Maleic anhydride-modified
PE	Polyester
PLA	Poly (lactic acid)
WRHA	White rice husk ash
UPR	Unsaturated polyester resin

CHAPTER 1

INTRODUCTION

1.1 Background of study

Natural fibers are highly demand as filler in polymer composites. This is due to their unique properties such as biodegradable, renewable, low cost, environmental friendly and so forth. Currently, it is in high demands for many industries in producing various applications such as automotive, construction and aerospace [1]. Nevertheless, everything has its own disadvantage same as in this material; it is lack in term of mechanical properties such as tensile strength and modulus, flexural strength and modulus and impact strength [2]. However, there is a previous study proved that one of the best way that mechanical properties can be enhanced is by using the synthetic reinforcing filler [3,4] such as. Rice husk (RH) is a natural fiber that gains much attraction where it is demanded by industry year by year.

In addition, there is a previous study about the use of RH in producing composites along with synthetic polymer [5-9]. It is well known that using polymer and one or more solid fillers help in gaining several advantages and specifically a combination of the main properties of two or more solid phase [10]. Meanwhile polypropylene reinforced with rice husk is currently reported during a mechanical and morphological study where rice husk is incorporated into PP and then percentage of water absorption is calculated. The result observed shows that, the increase percentage of rice husk will increase the amount of water absorbed and reduced in tensile strength [11].

Thermoplastics are mostly used in the manufacture of plastic or wood composites among the various polymer matrices [12]. One of the most important thermoplastic is the polypropylene and due to its transparency, fluidity and good electrical insulation properties, it is a greatly demand material [13]. Currently, polypropylene which acts as thermoplastic is been used and a lignocellulose material (rice-husk flour) as the reinforcing filler. The composites formed are used to examine physical, mechanical and morphological properties.

Nevertheless, natural fibers has few weaknesses such as degradation of thermal and mechanical during processing which is not good in making appliances. In addition, it has poor wettability which make it incompatible with other polymer as well as having ability to absorb high moisture content in fibers. The main drawbacks of natural fibers are it cannot mix well with hydrophobic matrix since it is a hydrophilic. However, it can be improved by treating with coupling agent which is *struktol.*

1.2 Problem Statements

One of the most important aspects in the materials development of thermoplastics is to achieve a good combination of properties and processability at a moderate cost. As far as mechanical properties are concerned, the main target is to strike a balance of stiffness, strength and toughness. So far, not much study has been reported on RH filled polypropylene composites. Therefore, more efficient utilization of rice husk is urgently needed. One of the efforts is to produce value-added products such as rice husk polymer composites from these important bio-resources, several factors that influence and affects the properties of the composites need to be considered. Thus the optimum formulation of the polymer composite will be investigated.

1.3 Research aim and objectives

The aim of this research is to determine the effect of various parameters on the mechanical properties of rice husk polypropylene composites. The specific objectives of this research are:

1. To determine the optimal parameter level of rice husk polypropylene composites and filler loading.

2. To investigate the effect of water absorption on mechanical and morphological properties of injection molded rice husk -polypropylene composites immersed in different liquids

1.4 Scope and limitation of work

This study focuses on investigating mechanical testing which are tensile, flexural and impact properties of rice husk filled polypropylene composites with injection struktol compatibiliser. Then the study was carried out on effect of morphological and performance deterioration of injection-molded rice husk-polypropylene composites due to various liquid uptakes such as sea water, distilled water and lubricant oil. The water immersion was conde=ucted according to ASTM D570 standard. The tensile properties of polypropylene composites were conducted by using the ASTM D638 standard, flexural properties ASTM D790 standard, and then impact test and SEM was performed after that.

1.5 Structure of the thesis

A literature review of research work in various areas relevant to this research is presented in Chapter 2. The review started with polymer composites used in engineering products. The reviews also cover the natural fibre and rice husk, their composites and past research on natural fibre composites. The use composite along with PP and other polymer is presented along with different level of parameters. Mechanical properties of rice husk polypropylene composites have also been presented. The materials and methods of rice husk polypropylene composites are described in Chapter 3. The results of the study are discussed in Chapter 4. Conclusions and recommendations for future work are presented in Chapter 5.

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