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Academic Session : 2015/2016

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ASSOC.PROF.DR. DEWAN MUHAMMAD
NURRUZAMAN

Date:

Date:

MECHANICAL PROPERTIES AND CHARACTERIZATIONS OF
POLYPROPYLENE BASED COMPOSITE

NORUL AMIERAH BT NOR ZAMANI

Report submitted in partial fulfillment of the requirements
for the award of the degree of
B.Eng. (Hons.) Manufacturing Engineering

Faculty of Manufacturing Engineering
UNIVERSITY MALAYSIA PAHANG

June 2016

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I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of the Bachelor of Manufacturing Engineering (Hons.)

Signature :
Name of Supervisor : Assoc. Prof. Dr. Dewan Muhammad Nurruzaman
Position : Senior lecturer
Date :

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Name : Norul Amierah Binti Nor Zamani
ID Number : FA12026
Date :

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LIST OF SYMBOLS

ε	Total strain, Bandwidth parameter
L_0	Initial length of the specimen
L	Final length
Gpa	giga pascal
Mpa	mega Pascal
J	joule
Kpa	kilopascal
mm	millilitre
kN	kilo newton
°C	degree Celsius
J/m	joule per meter

LIST OF ABBREVIATIONS

ASTM	American Society for Testing and Materials
CATIA	Computer aided three-dimensional interactive application
CAD	Computer-aided drafting
PP	Polypropylene
PA6	Polyamide 6
GF	Glass fibre
UTS	Ultimate tensile strength
UTM	Universal testing machine
OM	Optical microscope

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ABSTRACT

Polypropylene based composite is widely applied in the industry especially in automotive applications, due to their excellent mechanical properties, low cost and can be easily produced. This research is directed towards obtaining the mechanical properties and characterisation of polypropylene based composite for different objectives. Though the first objective was to prepare and fabricate the specimen with five different composites. The fabrications of specimen are useful in designing products where quality of the composite cannot be compromised. In this research, the mechanical properties that were studied include tensile properties and impact properties. Surface fracture of specimen were obtained and used to predict these properties as functions of corresponding compositions of the composites by using optical microscope. In this research, the samples were prepared by injection moulding process with standard of ASTM D638. Pure polypropylene, nylon and glass fibre were mixed according to the desired mixing ratio and injection moulded into dog bone-shaped in order to test its Ultimate Tensile Strength (UTS) and Impact Strength of the mixed materials. After the specimens produced, they undergo the tensile test and impact test in order to test their mechanical properties. As a result, it is concluded that the specimen of pure polypropylene obtain high tensile stress at maximum load and high impact strength. Thus, the results obtained shown an opposite output compared to the hypothesis due to the problem during fabrication of the specimens. The fractured specimens for both testing have undergone the microstructure analysis. The surface fractured was analysed by using optical microscope in order to see the different surface between the composites. Therefore, it is concluded that the fractured surface of 100% polypropylene have smooth surface compared to the specimen with contain of nylon and glass fibre.

ABSTRAK

Komposit berasaskan **Polipropilena** digunakan secara meluas dalam industri terutamanya dalam aplikasi automotif disebabkan kerana sifat-sifat dan mekanikal yang baik, harga yang rendah dan senang untuk dihasilkan. Kajian ini adalah berasaskan terhadap untuk mendapatkan sifat-sifat mekanikal dan percirian Komposit berasaskan **Polipropilena untuk objektif yang berbeza. Objektif pertama adalah menyediakan dan memalsukan specimen untuk lima jenis komposit berbeza. Pemalsuan specimen adalah berguna dalam mereka bentuk produk di mana kualiti produk komposit tidak boleh dikompromi. Dalam kajian ini, sifat-sifat mekanikal telah dipelajari termasuk “tensile properties” dan “impact properties”.** Permukaan specimen yang patah telah dapat dan digunakan untuk menjangka sifat tersebut sebagai fungsi yang sepadan komposisi bagi komposit dengan menggunakan mikroskop optik. Dalam kajian ini, sampel telah disediakan melalui proses pengacuan suntikan dengan standard ASTM D638. Polypropylene tulen, nilon dan gentian kaca dicampur dengan kadar nisbah yang tertentu dan di masukkan ke dalam mesin pengacuan suntikan untuk mendapatkan bentuk “dog bone” tersebut bagi menjalankan ujian kekuatan tegangan dan ujian kekuatan kesan. Setelah itu, spesimen tersebut diuji kekuatan tegangan dan ujian kekuatan kesan untuk menguji sifat-sifat mekanikal. Secara keseluruhan, ia didapati bahawa spesimen “Polypropylene” tulen menunjukkan kekuatan tegangan yang tinggi pada beban maksimum dan kekuatan berimpak yang tinggi. Oleh itu, keputusan yang diperolehi menunjukkan hasil yang bertentangan berbanding hipotesis kerana masalah semasa fabrikasi spesimen. Spesimen patah untuk kedua-dua ujian telah menjalani analisis mikrostruktur. Permukaan patah dianalisis dengan menggunakan mikroskop optik untuk melihat permukaan yang berbeza antara komposit yang dihasilkan. Secara keseluruhan, didapati spesimen yang mengandungi 100 peratus “Polypropylene” mempunyai permukaan licin berbanding spesimen dengan mengandungi nilon dan gentian kaca.

CHAPTER 1

INTRODUCTION

1.0 BACKGROUND OF RESEARCH

Polypropylene (PP) is a thermoplastic polymer has been used in large quantities in numerous fields of applications for many years. Polypropylene also known as polypropene is used in a wide variety of applications including households and in commercial and industrial applications. Nowadays, polypropylene is one of the fastest growing polymers. Much of this growth is assigned to polypropylene's ability to dislocate the conventional materials such as metal, wood, glass and other thermoplastic at lower cost. The main source of synthetic plastics is crude oil. Besides, the coal and natural gas are other materials used to produce plastics.

Polypropylene plastics play a huge role in reducing the world's economic growth where they are low in cost production and can be easily produced. The production of polypropylene has increased drastically over the years with increasing the production of polypropylene made products by reason of the polypropylene is widely used in the world. Then, polypropylene is widely applied in the industry and is usually combined with polymer based composite aiming to improve its mechanical properties and characterization (Fernandes, Correlo, Mano, & Reis, 2014).

As to this, this research was done to explore the effect of mixing pure polypropylene with polymer composite for the mechanical properties and characterization of tensile strength impact strength.

1.1 PROBLEM STATEMENT

The usage of polypropylene in the production of plastic products today has widely expanded throughout many industries in the world. In industries, the polypropylene materials are broadly used in their production since polypropylene plastic presents more benefits to the users. Industries today tend to produce polypropylene products without stress on its mechanical properties and characterization by reason of reducing production cost rather than the quality of the product. The usage of pure polymer in the production of product will produce the lower quality of product which is low in strength of the product. To increase the quality of the product, industries produce the product with mixing the pure polypropylene and polymer composite material and also to save the PP materials. Besides, the combination between these materials is to improve their mechanical characterization and properties.

As to this, the polymer composite material is one of the factors in increasing the quality of product. However, until today, the research on the mechanical properties of polymer composite is not widely explored in open literature. Besides that, not much input on the properties of the polymer composite in mechanical is comparable with the pure polypropylene materials. Thus, the study on the mechanical properties and characterization of polypropylene based composite of tensile strength and impact strength is necessary.

In this study, the percentage mixing of polymer composite will be manipulated in order to investigate the tensile strength and impact strength of polypropylene based polymer composite.

1.2 OBJECTIVE

The main objectives of this project are:

1. To fabricate a specimen of polypropylene based polymer composite with the standard size ASTM D638 and ASTM D256.
2. To test tensile properties of the polypropylene based composite by carrying out the Ultimate Tensile Strength (UTS) test.
3. To test the impact properties of the polypropylene based polymer composite by carrying out the Izod impact test.
4. To characterize the fractured specimen.

1.3 PROJECT SCOPE

This research is focused on carrying out the tests and analysis in determining the percentage of polymer composite that is suitable to be mixed with virgin or pure polypropylene and then analyzing the mechanical properties and characterization of tensile strength or in other word is Ultimate Tensile Strength (UTS) test. The tensile strength test is tested by using Universal Testing Machine (UTM) INSTRON 3369. Besides, the impact strength is tested by using impact machine by INSTRON- CEAST 9050. On the other hand, to characterize the failure specimen The tests and experiments are carried out in a laboratory located in Faculty of Manufacturing.

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