AN STUDY ON BENDING PROPERTIES OF ACRYLONITRILE BUTADIENE STYRENE (ABS) SUBJECTED TO THERMAL DEGRADATION

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Report

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MAY 2017

DECLARATION

"I hereby declare that the work in this project is my own except for summarize and quotations which been duly acknowledgement."

Signature :

Author : NUR IZZATI BINTI ABD MAJID

Date : 24 MAY 2017

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Structure & Materials).

Signature :. .....

Name of Supervisor : DR MIZAH BINTI RAMLI

Date : .....

ACKNOWLEDGEMENT

First of all, I would like to thanks to my supervisor, Dr Mizah Bt Ramli for her guideline and help to me in order to finish this project with success. Without her guideline, I will never complete my Final Year Project (FYP). I would like to thanks to her for her support and time she spend to me in order to help me.

Next, I would like to thanks to my second examiner which is Dr Zulkefli Bin Selamat for his willing to check and correct my report. Thanks to all the comments and suggestion that he give to me

I also would like to thanks to Universiti Teknikal Malaysia Melaka (UTeM) especially to Faculty of Mechanical Engineering (FKM) for providing me all the facilities and equipment for me to conduct this project. Not forget to all the technician that always guide me on how to use the facilities that have been provided from UTeM.

Lastly, I would like to dedicate my thanks to my family and all my friends. A lot of thanks to my family for their love, support and encouragement they give to me while I am doing this project. To all my friends I would like to thanks to them for their advice and tolerate me over the past 3 years.

ABSTRACT

ABS is one of the thermoplastic polymer that can be mold under a specific temperature and become solid again when it cooling Now days, the application of ABS polymer are widely been used in many type of application such in building, medical, construction and toys. The main objective of this project is to investigate the bending properties of ABS material at varying temperatures and times. Besides that, this project also is to characterize the morphological surface of ABS material at different temperatures and times. In this project, ABS polymer are used to investigate the bending properties of ABS polymer after heat applied on it. First of all, the pure ABS material will be fabricated by using hot press machine. After that, specimen under thermal degradation condition will be heated with temperature of 50°C and 80°C for 10 hours, 30 hours and 50 hours. Each condition will have 3 specimen. After heat are applied on the specimen, the bending testing are being conducted to the specimen. Lastly, the morphological study will be conducted by using SEM. The result get from this testing is maximum load (N), flexure stress at maximum load (MPa) and modulus (MPa). At the end of this project, a discussion about the result obtain from the testing are made. From experimental result, it can be conclude that the maximum load, flexure stress and modulus will be decreases as the temperature and time increases. From SEM result, it shows that the specimen are in ductile at room temperature. After being heated, the specimen slowly become more brittle.

ABSTRAK

ABS adalah salah satu polimer termoplastik yang boleh diubah bentuk atas suhu yang tertentu dan boleh menjadi pepejal semula selepas disejukkan. Pada zaman sekarang, ABS telah banyak digunakan di dalam banyak peralatan contohnya sepert di dalam bangunan, pembinaan,alat permainan dan perubatan.Tujuan utama projek ini dijalankan adalah untuk mengenalpasti ciri-ciri lengkungan ABS di suhu dan masa yang berbeza. Selain itu, projek ini juga bertujuan untuk mengenalpasti permukaan morphologi. Mula-mula bahan akan difabrik menggunakan "hot press machine". Kemudian, specimen akaan dipanaskan pada 50°C dan 80°C untuk 10 jam, 30 jam dan 50 jam. Setiap keadaan akan ada 3 speimen. Selepas dipanaskan, ujian lengkungan aakan dijalankan untuk mendapat beban maksimum, kekeuatan lengkungan dan modulus.Di akhir projek ini, perbincangan mnegenai keputusan yang didapti telah dibuat. Daripada keputusan eksperimen, satu rumasan telah dibuat iaitu beban maksimum, kekeuatan lengkungan dan modulus akan berkurang jika suhu dan masa berambah. Result daripada SEM menunjukkan specimen dalam ductie pada suhu bilik. Setelah dipanaskan, ia berubah kepada ductile.

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ABS	Acrylonitrile butadiene styrene
SEM	Scanning Electronic Machine
SD	Standard Deviation

LIST OF SYMBOL

σf	Flexural stress
Ɛf	Flexural strain
Ef	Flexural modulus
%	Percentage
∑	Total sum
Ẋ	Mean
S	Standard deviation

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

1.1.1 Polymer

A polymer is a type of chemical compound that are made up of small molecules that are arranged in a repeating arrangement to produce a larger and stronger molecule. Repeating units are often made of carbon and hydrogen. There are various natural polymers such as shellac, cellulose and rubber. In year 1550, the explorer from British had been exposed the ancient Mayan civilization in Central of America. The use of polymer had been found as the children in Central America were fond of playing with balls made from local rubber trees at there.

Nowadays, the application of the polymer had been commonly use in engineering field such as in automotive and aerospace. It are widely used in perfusion medical devices as well as vascular catheters (Desrousseaux, et al, 2015. Polymers have many benefits compare to metal or ceramic.

The advantages of polymers are it has low density which it can cause to lower cost due to the volume cost. Besides that, polymers also resist with chemical and weather attack. Furthermore, polymers also are very flexible which the polymers are able to adapt to high strains with an attractive degree of resilience. Polymers can be classified into three categories which are thermoplastic, thermoset and elastomer. Thermoplastic is a plastics that

becomes soft or moldable under a specific temperature, while thermoset is a plastic that soften when heated and can be molded but not permanently. In other hands, elastomer is a polymer with have viscosity and elasticity.

1.1.2 Thermoplastic Polymer

Thermoplastic polymer is a polymer that can be mold under a specific temperature and become solid again when it cooling. Thermoplastics are different from thermosets polymers which form irreversible chemical bonds throughout the curing process. Thermoplastic have common range of properties because thermoplastics are non- corrosive, lighter and are more cheap compare to metals (Elewe, 2014).

Furthermore, thermoplastic materials also are good insulators, electric and thermal. The common methods that involve in thermoplastic process are injection molding, extrusion, hot press and thermoforming. The advantage of thermoplastic are it is suitable for many different type of application because it have high strength, cheap in process and lightweight. Besides that, thermoplastic also are energy efficient in manufacture and processing as the components can be made in very high volume with high accuracy and low cost. There are many examples of thermoplastics such as Polyester, Polypropylene, acrylonitrile butadiene styrene and many more.

1.1.3 Acrylonitrile Butadiene Styrene (ABS)

Acrylonitrile butadiene styrene (ABS) is an opaque thermoplastic polymer material made from the monometers Acrylonitrile, 1,3-Butadiene and Styrene. ABS terpolymer had been found in 1948 (Chanda and Roy, 1993). Nowaday, ABS polymer is widely been use in many various application. Various applications of ABS are in building and construction, personal care products, toys, computer and business equipment and also in medical devices (shuying Yang, Jose Rafael Castilleja, E.V. Barrera, Karen Lozano, 2003).

Besides that, ABS also is applied in the automotive industry and the electrical/electronic segment.

Figure 1.1: Example of ABS Polymer

(Source: http://dir.indiamart.com/impcat/abs-plastic-granules.html)

ABS is strong and can durable even at low temperature. The material quality and ease of processing made the ABS becomes the main polymer in engineering field. ABS is a flexible design with excellent surface quality. Besides that, ABS also can resist to chemical and impact resistance. Furthermore, ABS is a cheap and strong plastic that can stand well to external impacts of force. One of the most main characteristic of thermoplastic is their stress strain performance in flexure (PM Dr Shahrir Hashim).

The standard that usually had been used to find behavior in flexure of polymer is ASTM D750 which made by using a simple supported beam test specimen that had been loaded at mid-span. The flexural strength at yield and flexural modulus can be used to identify the endurance of a product to short-term loadings (Norbert, 1971). Table 1 below shows the mechanical properties values of virgin ABS (PEYDRO, 2014)

Table 1.1: Mechanical Properties of Virgin ABS

Mechanical Properties	ABS
Tensile strength (MPa)	44
Elongation at break (%)	12
Charphy notched impact strength (kJ/m^{-2})	19
Hardness	75 (Shore D)
Source	BASF

1.2 PROBLEM STATEMENT

The application of ABS polymer has been widely used in major application such as in building and construction, personal care products, toys, computer and business equipment as well as medical devices. Nowadays, ABS polymer had been commonly used as a casing for organic light-emitting diode (OLED) across the globe. For example ABS had been applied in button display of washing machine. The button display of washing machine will experience bending-effect because different amount of forces will be applied on it through its usage.

Besides that, button display of washing machine also will be exposed to different environmental temperatures such as the temperature at night and day. Therefore, it is important to investigate the bending properties of ABS polymer subjected to varying cyclic temperature in order to study the limit and strength of the ABS polymer.

1.2 OBJECTIVES

This project is aim to develop a bending properties of the Acrylonitrile butadiene styrene (ABS). To achieve this aim, the objectives of this project are:

1) To investigate the bending properties of ABS material at varying temperatures and times.

2) To characterized the morphological surface of ABS material at different type of temperatures and times.

1.3 SCOPE

The first scope of this project is to conduct literature review on acrylonitrile butadiene styrene (ABS). To conduct this literature review, journal, reference book and article that related to this project will be referred and reviewed.

Second scope is to find and prepare a raw material of ABS to fabricate. There will be 28 specimens to fabricate. In each different type of temperature which is 50°C and 80°C for 10 hours, 30 hours and 50 hours, 7 specimens will be uses in bending testing. Each temperature needs 7 specimens to check their bending properties in order to get the accurate result. For this project, the specimens will be test at four different of temperature.

Third scope of this project is to fabricate the raw ABS material with the dimension of length is 60mm, width is 25mm. and thickness is 3mm. The machine that uses to fabricate all the specimens is hot press machine. So, all the 28 specimens will be fabricated with the dimension given. After that, the process of filing is required for surface finishing.

This practice attempts to conduct the bending testing. Oven machine is use to prepare a test specimens for further physical test. All the specimen that had been fabricated will being place into oven at varying temperature After that, bending testing will be conduct to all the specimens that already put in the oven.

Next scope is to study morphological chart. After the bending testing has done, analysis all the data and make a morphological chart in order to list up all the different ways or ideas. This chart is a visual aid in order to detect the effect of bending properties at varying temperature. Besides that, purpose of morphological study also is to analyze the structure of an ABS material after the bending testing.

Final scope of this project is to write and prepare a formal report based on the result get from the test and analysis. There is five chapter for this project report. Chapter 1 is introduction, chapter 2 is literature review, chapter 3 is methodology, chapter 4 is result and discussion, while chapter 5 is conclusion.

CHAPTER 2

LITERATURE REVIEW

For this chapter, a summary from a journal that related with this project will be made. ABS is one of thermoplastic polymer material that made from the manometer Acrylonitrile, 1,3-Butadiene and styrene. The material quality and ease of processing made the ABS becomes one of the most important polymer in engineering. Now days, application of ABS polymer are widely been used in many application such as in building, construction, toys and medical device. ABS are widely been used because of its properties such as it has good mechanical properties and chemical resistance. It also have good processing characteristic and have flexible design with excellent surface quality. ABS also are strong and can durable at low temperature. Besides that, ABS also is a cheap and strong plastic that can stand well to external stress strain performance in flexure.

2.1 RESEACRH ON ABS MATERIAL

Rachida Krache et al in their study use Arcylonitrile-Butadiene-Styrene (ABS) and Polycarbonate (PC) to get the bending properties of PC/ABS blends by using flexural test. 3 point bending experiment had been conduct at the cross head speed of 5mm/min. The specimen dimension were 4mm in thickness and 10 mm in width. The distance between the supports was 100mm. The result shows that all the flexural modulus values obtained for the PC/ABS blends are higher than the pure components of the blends. Therefore, components of highest modulus contributes to the resulting value in a better extend than the corresponding to the compositions. The SEM result show that the morphology of the PC/ABS blends was found to be co-continuous (Krache, et al, 2011).

Mithun V. Kulkarni et. Al. in their study investigate about the tribological behaviors of ABS under condition of dry friction, water absorbed and electroplated. For the result, the surface of ABS has been analyzed by using SEM. They coated the sample with 10mm thickness of gold-palladium in order to expose the wear mechanisms. The result shows that mechanical and thermal properties of water absorbed condition is higher compared to condition of dry friction and electroplated. Besides that, the effect of applied load on wear coefficients under 24 hours water absorbed also is higher compared to other conditions. Figure 2.1, 2.2 and 2.3 show that the SEM micrographs of worn surface under condition of dry sliding, 24 hours water absorbed and electroplated (Kulkarni,2016).

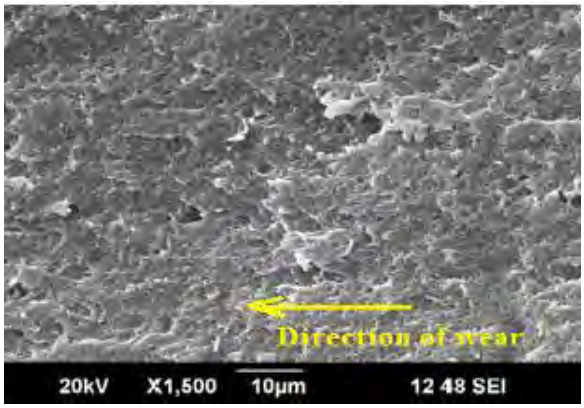

Figure 2.1: SEM Micrographs of Worn Surface of Normal ABS

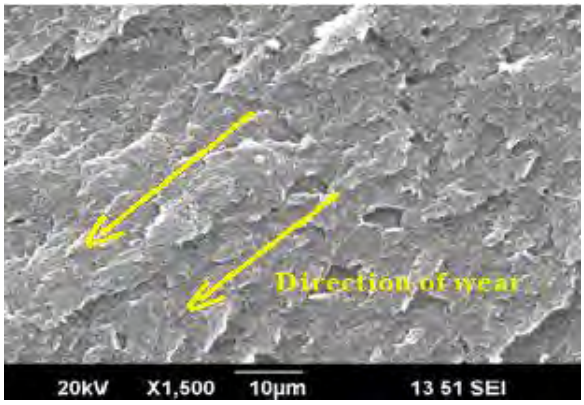

Figure 2.2: SEM Micrographs of Worn Surface Under 24 Hours Water Absorbed Conditions

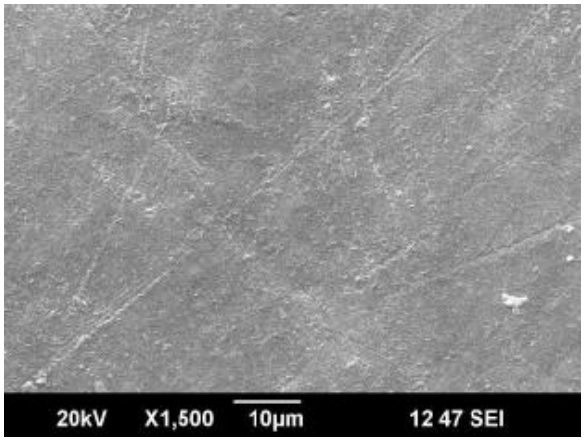

Figure 2.3: SEM Micrographs of Worn Surface Under 24 Electroplated Conditions

Filip Gorski et. al. in their research study about the comparison of strength and plastic characteristic by the ABS sample that using FDM technology and injection molding. The result shows that ABS that use injection molding shows a better strength and plastic characteristic. Besides that, they also discuss about which oriented of sample shows the excellent result of bending properties. The testing had been carried out until the deflection thickness is 6mm or until the sample failure. There will be 9 sample that has different orientation which is 0°, 30°, 45°, 60° and 90° for both side and flat axis. From the results, it shows that the lowest angle of oriented will produced more excellent strength of bending properties (Gorski, 2015).