THE STUDY OF OPTIMUM CONDITION TO PRODUCE RUBBER INDUCED POLYMER (POLYPROPYLENE)

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The study of Optimum Condition to Produce Rubber Induced Polymer (Polypropylene)

Thesis submitted in accordance with the partial requirements of the Universiti Teknikal Malaysia Melaka for the Degree of Bachelor of Engineering (Honours) Manufacturing (Engineering Material)

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I hereby, declared this thesis entitled "The Study of Optimum Condition to Produce Rubber Induced Polymer (Polypropylene)." is the results of my own research except as cited in references

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APPROVAL

This thesis submitted to the senate of UTeM and has been accepted as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Engineering Material). The members of the supervisory committee are as follow:

……

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ABSTRACT

This project is entitled the optimum condition to produced rubber induced polymer (polypropylene). Since blending of two different materials together enhanced the mechanical properties of a material, flexural strength of recycle rubber induced polypropylene is determined. Emphasize is took on effect of different weight percentage which is varied from 10% to 30% rubber. Recycle rubber from motorcycle tube is crushed into small particles using crusher machine. Rubber and polypropylene were then blended in internal mixer and extruder. Next, the blend is crushed and hot pressed before the flexural specimen is fabricated. Flexural test is conducted and the blend with 10 wt% of rubber has the highest value of flexural strength. The flexural result showed decreasing of flexural strength as increasing of rubber wt%. Blend with 10 wt% and 20 wt% rubbers enhanced the flexural strength but not for blend with 30 wt% of rubber. Formation of void inside the blend is the main factor that influenced the result. Poor interfacial compatibility of the blend restricted flexural strength of PP to increase by mixing with recycle rubber. At the end of this study, the optimum condition of this blend determined and it is PP/10 wt% recycle rubber.

ABSTRAK

Projek ini bertajuk keadaan yang optimum untuk menghasilkan campuran polimer (polipropelina) dan getah. Oleh kerana mencampur dua polimer dapat meningkatkan sifat-sifat mekanikal sesuatu bahan, kekuatan bengkokan campuran getah terpakai dan polipropelina telah ditentukan. Kesan perbezaan peratus berat yang telah dibezakan dari 10% ke 30% diberi penekanan. Getah terpakai yang diambil dari tiub motosikal telah dihancurkan menjadi cebisan-cebisan kecil dengan menggunakan mesin penghancur. Getah tersebut dicampurkan kepada polipropelina dengan menggunakan mesin pencampuran dalaman dan mesin penyemperitan. Selepas itu, campuran tersebut dihancurkan dan di 'hot pressed' sebelum spesimen ujian bengkokan dihasilkan. Ujian bengkokan telah dijalankan dan didapati campuran yang mengandungi 10 wt% getah mempunyai kekuatan bengkokan yang paling tinggi. Keputusan ujian bengkokan tersebut menunjukkan kekuatan bengkokan berkurang jika peratus berat getah meningkat. Campuran mengandungi 10 wt% dan 20 wt% getah dapat meningkatkan kekuatan bengkokan tetapi tidak pada campuran mengandungi 30 wt% getah. Keputusan ujian tersebut dipengaruhi oleh pembentukan ruang kosong di dalam campuran tersebut. Kelemahan ikatan antara fasa menghadkan peningkatan kekuatan bengkokan campuran tersebut berbanding kekuatan bengkokan asal polipropelina. Setelah kajian ini lengkap, didapati keadaan yang paling optimum untuk menghasilkan campuran getah terpakai dengan propelina telah ditentukan dan ia adalah campuran PP/10 wt% getah terpakai.

DEDICATION

For all your advices, supports and encouragements, this thesis is gratefully dedicated to my beloved family and all my friends. Thank you very much for your continuous support and efforts towards the publication of this thesis.

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

PVC - Polyvinyl Chloride

PE - Polyethylene

PP - Polypropylene

PS - Polystyrene

Tg - Glass Transition Temperature

LDPE - Low Density Polyethylene

HDPE - High Density Polyethylene

US - United State

σ - Stress

E - Modulus Elasticity

ε - Strain

E_B - Flexural Modulus

UV - Ultra Violet

HIP - High Impact Polystyrene

PET - Polyethylene terephthalate

PVA - Polyvinyl Alcohol

Wt% - Weight Percentage

ASTM - American Standard of Testing Material

kN - Kilonewton

MPa - Megapascal

GPa - Gigapascal

HVA - *N*,*N*′-*m*-phenylenebismaleimide

DCP - Dicumyl Peroxide

CHAPTER 1
INTRODUCTION

1.1 Background of the Study

Polymer blend or mixing is a mixture of two or more polymers with improvement in the properties. The important of mixing two or more polymers are to achieve enhanced properties such as toughness, processability, chemical resistance, weatherability, heats stability, and flow behavior. In describing a mixing, the elements that want to be mixed need to be determined whether they are fully miscible, partially miscible, or totally immiscible. Two immiscible polymer need of adding compatibilizer in order to let them well mixed. Elements in a polymer blend do not have covalent bond between them like copolymers but there is multiphase system. The optimum condition to produce polymer blend can be determined by studying the mechanical properties of the blend. It is depends on the composition of blend elements and method of producing it such as internal mixer and extruder. In this study, the optimum condition of recycle rubber induce polymer (Polypropylene) mixing is carried out. The recycle rubber used in this study is taken from old motorcycle tube. Consequently, the old motorcycle tube needs to be crushed into tiny bits before mixing it with polymer resin. Main components that are required to be consider in this study are ratio of the materials involved, process parameter such as temperature and time, and the method of producing it. After the polymer blend has been produce, flexural test is conducted to determine the best processing method, composition and process parameter in producing recycle rubber induce polypropylene polymer blend.

1.2 Hypothesis

After completing this study the expected results that will be achieved are:

i). Recycle rubber will enhance the flexural properties of the polypropylene due to flexibility of rubber.

ii). Adding of compatibilizer will be needed in varying the rubber percentages from 10% to 30% by weight fraction in the blend.

1.3 Problem Statements

Rather than synthesizing a new polymer, combining two or more existing polymer is less expensive. The properties of existing polymers are modified to exhibit the desired properties according to customer needs. Rubber and polypropylene have different characteristics for example elasticity, heat resistance and also durability. By mixing these materials, hope to get a new polymeric materials that exhibit a better properties and performance. The method of producing it needs to be determined in order to get the most suitable one.

1.4 Objectives

The objectives of this study are:

i). To determine the flexural strength of recycle rubber induced polypropylene.

ii). To determine the optimum condition of recycle rubber and polypropylene blend.

1.5 Scope of Study

This study will focus in the method of producing rubber induced polypropylene by varying the composition of the blend. The composition will be varied by weight percentages. Techniques of polymer mixing such as internal mixer and extrusion will be discussed in this study in order to get the most suitable method in mixing these polymers into applicable polymeric material. Besides that, techniques in using equipment such as extruder, internal mixer, and hot press also will be presented in this study. After enable to produce the polymer blend from waste rubber and polypropylene, the flexural properties of the material will be studied by using ASTM test method. However, other properties such as tensile strength, impact strength, and thermal characteristics will not be covered in this research.

CHAPTER 2
LITERATURE REVIEW

2.1 Polymer

2.1.1 General Overview of Polymer

Polymers play an extremely important role in today's society. It is crucial to understand the structures and properties of polymeric materials. In fact, polymers are macromolecules consist of a large number of small molecules called 'mers' that have been joined together either naturally or synthetically to make up their structure. Polymeric materials synthesized by polymerization process from their monomers. For example, polyethylene is derived from ethylene monomers which are linked together to get a macromolecule. Polymers which are derived from one type of monomer are called homopolymer, but when they are derived from two or more types of monomer they are called copolymer. Commonly, polymers are called as plastics by the society which is refer to one class of polymers known as thermoplastics. Actually, there are three classes of polymeric materials which are thermoplastic, thermoset, and elastomer. Polymeric materials are divided into its class according to their structure and properties (Callister, 2003).

2.1.2 Thermoplastic

In processing thermoplastic materials, heat is required to make them processable. Thermoplastics can be either linear or branched structure (refer figure 2.1 and 2.2). In thermoplastics, single linear or branched structures are held together by van der waals forces. These characteristic lead thermoplastics soften when heated. Besides that, these polymers can be reheated and reformed. During heating, weaker bond lose their hold and lead movement of monomers in the macromolecule. In other word, thermoplastics have an ability to be reprocessed by heating into molten state and reshaped by mold (Higgins, 1998). Most common thermoplastic materials are polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), and polystyrene (PS).

Figure 2.1: Linear chain
Source: William D.C, Jr. (2003)

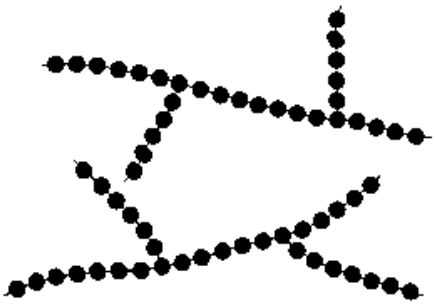

Figure 2.2: Branched chain
Source: William D.C, Jr. (2003)

2.1.3 Thermoset

Differ to the thermoplastics, thermoset can't be reprocessed by heating to molten state due to their network and cross-linking polymer chain (refer figure 2.3 and 2.4). This type of structure is linked together by primary bonds which are form between chains. Covalent bonds are developed between chains and avoid movement of monomers. So, thermoset do not soften when heated to elevated temperature. The advantages of this class of polymer are excellent thermal stability and rigidity. Epoxy, polyurathanes, amino resins, and phenol-formaldrhyde are classified in this class of polymer.

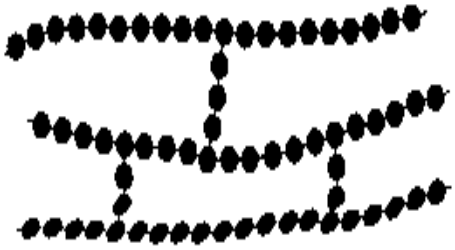

Figure 2.3: Crosslinked chain

Source: William D.C, Jr. (2003)

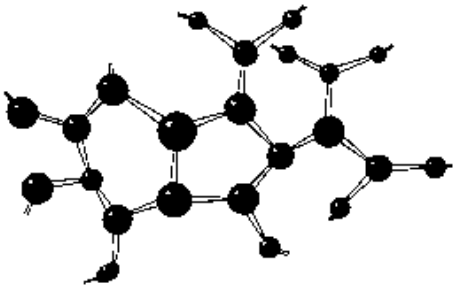

Figure 2.4: Network chain (3 dimensional)

Source: William D.C, Jr. (2003)

2.1.4 Elastomer

Polymers which are showing rubbery or elastic behavior comprised in this class of polymer. When a weak stress applied to elastomers, they will deform and quickly return to their initial shape and dimension after the stress is released. Normally, elastomers will stretch from 200% to over 900% of their initial length at room temperature and come back to their original length when the tensile stress is released (Jacob & Kilduff, 2001). Examples of elastomer are polyisoprene, silicone, and polychloroprene.

2.2 Polypropylene (PP)

Polypropylene is a thermoplastic material that has chemical formula of $(C_3H_6)_n$ with presence of methyl group (refer figure 2.5). Melting temperature, Tm, of PP is 165 °C and glass transition temperature, Tg, -10 °C. If polypropylene is processed in temperature up to 286 °C, it will be degraded.

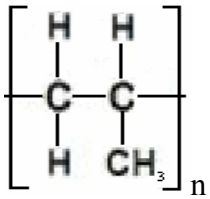

Figure 2.5: Repeating unit of PP

2.2.1 Mechanical Properties of Polypropylene

Compare to low density polyethylene (LDPE), PP is less flexible due to presence of methyl group in the polymer chain. Methyl group restricts the rotation of its chain. In addition, the methyl group also produces a better strength to PP. But, PP is less tough than the high density polyethylene (HDPE) and exhibits a much less brittle performance. This allows PP use as replacement to engineering plastics.