

**CHARACTERIZATION AND PROPERTIES OF
RECYCLED POLYPROPYLENE (RPP)/
CHLOROPRENE RUBBER (CR) BLENDS**

NURUL AZRA BINTI BAKARUDDIN

© This item is protected by original copyright

UNIVERSITI MALAYSIA PERLIS

2011



**Characterization and Properties of Recycled
Polypropylene (RPP)/Chloroprene Rubber (CR)
Blends**

by

**Nurul Azra Binti Bakaruddin
0930410420**

A thesis submitted in fulfilment of the requirements for the degree of
Master of Science (Materials Engineering)

School of Materials Engineering
UNIVERSITI MALAYSIA PERLIS

2011

UNIVERSITI MALAYSIA PERLIS

DECLARATION OF THESIS

Author's full name : NURUL AZRA BINTI BAKARUDDIN
Date of birth : 30 SEPTEMBER 1986
Title : CHARACTERIZATION AND PROPERTIES OF RECYCLED
POLYPROPYLENE (RPP)/CHLOROPRENE RUBBER (CR) BLENDS
Academic Session : 2009/2010

I hereby declare that the thesis becomes the property of Universiti Malaysia Perlis (UniMAP) and to be placed at the library of UniMAP. This thesis is classified as :

- CONFIDENTIAL** (Contains confidential information under the Official Secret Act 1972)*
- RESTRICTED** (Contains restricted information as specified by the organization where research was done)*
- OPEN ACCESS** I agree that my thesis is to be made immediately available as hard copy or on-line open access (full text)

I, the author, give permission to the UniMAP to reproduce this thesis in whole or in part for the purpose of research or academic exchange only (except during a period of _____ years, if so requested above).

Certified by:

SIGNATURE

SIGNATURE OF SUPERVISOR

860930-33-5086
(NEW IC NO. / PASSPORT NO.)

PROF. MADYA DR. IR. SALMAH HUSSEINSYAH
NAME OF SUPERVISOR

Date :21 OCTOBER 2011

Date : 21 OCTOBER 2011

NOTES : * If the thesis is CONFIDENTIAL or RESTRICTED, please attach with the letter from the organization with period and reasons for confidentiality or restriction.

ACKNOWLEDGEMENT

Assalamualaikum W.B.T. First of all, thank Allah S.W.T for giving me strength, patience and ability to successfully complete this thesis.

Foremost, I would like to express my sincere gratitude to my supervisor Associate Professor Dr. Ir. Salmah Husseinsyah for the continuous support in my master study and research. She helped me with her enthusiasm, inspiration, and great effort to explain things clearly and simply. Throughout my thesis-writing period, she provided encouragement, useful advices and motivations. I would also like to thank my co-supervisor Pn. Yusrina Mat Daud for her cared for me.

My sincere thank also goes to Dr. Khairul Rafezi Ahmad, Dean of School of Materials Engineering for his support in completion my research and thesis. I would like to thank the many technicians and PLV of Materials engineering especially Mr. Norzaidi, Mr. Mohd Nasir, Mr. Ahmad Hadzrul Iqwan, Mr. Lokman Ibrahim and Mr. Ismail Ibrahim for their generous effort and assistance in the laboratory's work. I wish to thank Dr. Supri and Dr. Ir. Suryadiansyah for their help and advices and not to forget to all staff in this school those help me directly and indirectly.

I am indebted to my friends and my postgraduate colleagues who are Marliza Mostapha@Zakaria, Mohd. Nasha'ain Nordin, Alida Abdullah, Farah Farhana Zainal, Liyana Ahmad Sofri, Norainiza Saud, Haryanti Ibrahim, Siti Salwa Mohd Shirajuddin, Romisuhani Ahmad, Lim Bi Ying, Tan Soo Jin, Nurul Razliana Razak, and Voon Chong Hoon for helped me to get through the difficult times, and for all the emotional support and camaraderie they provided. My days of completion my master would be extremely difficult without their help.

I wish to thank my entire family especially my father Bakaruddin Bin Hj. Md Ali and my mother Rusni Binti Tan for raised me, taught me, loved me and providing the financial support. Special thanks also to my late grandfather Hj. Md Ali Md Sood who always give his support from beginning to end. I dedicate this thesis to them. My grandmother, my sisters, my brothers, my brother in law, my uncles and aunties, and my cousins were particularly supportive.

Lastly, thanks to Universiti Malaysia Perlis for giving me a space to learn, an excellent facilities and opportunity to complete my thesis. Thank you very much.

- Nurul Azra Binti Bakaruddin -

TABLE OF CONTENTS

	PAGE
THESIS DECLARATION	iii
ACKNOWLEDGEMENT	iv
TABLE OF CONTENTS	v
LIST OF FIGURES	ix
LIST OF TABLES	xii
LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURES	xiii
ABSTRAK	xvii
ABSTRACT	xviii
CHAPTER 1: INTRODUCTION	
1.1. Research Background	1
1.2. Problem Statement	7
1.3. Objectives of Study	7
CHAPTER 2: LITERATURE REVIEW	
2.1 Polymer Blend	9
2.1.1 Classification of Polymer Blends	11
2.1.2 Compatibility and Miscibility in Blend	11
2.2 Thermoplastic Elastomer (TPE)	12
2.2.1 Classification and Properties of TPE	14
2.2.2 Applications of TPE	16
2.2.3 Thermoplastic Polyolefin Blends (TPOs)	16
2.3 Polypropylene (PP)	21
2.3.1 Classification and Properties of PP	23

2.3.2	Applications of PP	25
2.3.3	Recycling of PP	27
2.3.4	Polypropylene-Based Polymer Blends	28
2.4	Chloroprene Rubber (CR)	31
2.4.1	Applications of CR	33
2.5	Compatibilizers	34
2.5.1	Maleic Anhydride (MA)	36
2.5.2	Maleic Anhydride grafted Polypropylene (MAPP)	40
2.6	Dynamic Vulcanization	43
2.6.1	Vulcanization Methods	45
2.6.2	Accelerators	46
2.6.3	Activators	47
2.6.4	Dynamic Vulcanized Polymer Blends	48

CHAPTER 3: EXPERIMENTAL

3.1	Materials	52
3.1.1	Raw Materials	52
3.1.2	Curatives	53
3.1.3	Compatibilizers	54
3.2	Preparation of PP/CR and RPP/CR Blends	55
3.2.1	Mixing	55
3.2.1.1	Preparation of PP/CR and RPP/CR Blends with Different Blend Ratios	55
3.2.1.2	Preparation of Dynamic Vulcanized of RPP/CR Blends	56
3.2.1.3	Preparation of RPP/CR Blends with Compatibilizers	56
3.2.2	Compression Moulding	57
3.3	Measurement of Mechanical Properties	58
3.3.1	Tensile Test	58
3.3.2	Swelling Behaviour	58
3.4	Morphology Study	59
3.5	Differential Scanning Calorimetry (DSC)	59

CHAPTER 4: RESULTS AND DISCUSSION

4.1. Effects of Blend Ratios on the Properties of PP/CR and RPP/CR Blends	60
4.1.1. Tensile Properties	60
4.1.2. Swelling Behaviour	63
4.1.3. Morphology Study	65
4.1.4. Differential Scanning Calorimetry (DSC)	69
4.2. Effects of Dynamic Vulcanization on the Properties of RPP/CR Blends	71
4.2.1. Tensile Properties	71
4.2.2. Swelling Behaviour	74
4.2.3. Morphology Study	76
4.2.4. Differential Scanning Calorimetry (DSC)	78
4.3. Effects of Maleic Anhydride Grafted Polypropylene (MAPP) on the Properties of RPP/CR Blends	80
4.3.1. Tensile Properties	80
4.3.2. Swelling Behaviour	83
4.3.3. Morphology Study	85
4.3.4. Differential Scanning Calorimetry (DSC)	87
4.4. Effects of Maleic Anhydride (MA) on the Properties of RPP/CR Blends	89
4.4.1. Tensile Properties	89
4.4.2. Swelling Behaviour	92
4.4.3. Morphology Study	94
4.4.4. Differential Scanning Calorimetry (DSC)	96

CHAPTER 5: CONCLUSIONS AND SUGGESTIONS FOR FUTURE WORK

5.1. Conclusions	98
5.2. Suggestions for Further Work	99

REFERENCES	101
APPENDIX A	113
APPENDIX B	114
APPENDIX C	115

© This item is protected by original copyright

LIST OF FIGURES

	PAGE
Figure 2.1	The morphology of TPE. 14
Figure 2.2	Morphology of thermoplastic polyolefin blend (TPO). 18
Figure 2.3	Polymerization structure of PP. 23
Figure 2.4	Structure of isotactic, syndiotactic, and tactic PP. 23
Figure 2.5	The structure of chloroprene rubber (CR). 32
Figure 2.6	The structure of block and graft copolymers of compatibilizers. 35
Figure 2.7	Chemical structure of MA. 37
Figure 2.8	Chemical structure of MAPP. 40
Figure 2.9	Schematic structures for the morphology development of thermoplastic elastomer under dynamic vulcanization. 44
Figure 2.10	The formation of sulfur vulcanization. 46
Figure 2.11	Chemical structures of CBS and TMTD. 47
Figure 4.1	The effect of blend ratios on tensile strength of PP/CR and RPP/CR blends. 61
Figure 4.2	The effect of blend ratios on Young's modulus of PP/CR and RPP/CR blends. 62
Figure 4.3	The effect of blend ratios on elongation at break of PP/CR and RPP/CR blends. 63
Figure 4.4	Swelling percentage versus time of PP/CR and RPP/CR blends at different blend ratios. 64
Figure 4.5	Equilibrium swelling percentage versus blend ratios of PP/CR and RPP/CR blends at different blend ratios. 65
Figure 4.6	Scanning electron micrograph of tensile fractured surface of PP/CR (100/0) blends at magnification of 200X. 66

Figure 4.7	Scanning electron micrograph of tensile fractured surface of RPP/CR (100/0) blends at magnification of 200X.	67
Figure 4.8	Scanning electron micrograph of tensile fractured surface of PP/CR (70/30) blends at magnification of 200X.	67
Figure 4.9	Scanning electron micrograph of tensile fractured surface of PP/CR (40/60) blends at magnification of 200X.	68
Figure 4.10	Scanning electron micrograph of tensile fractured surface of RPP/CR (70/30) blends at magnification of 200X.	68
Figure 4.11	Scanning electron micrograph of tensile fractured surface of RPP/CR (40/60) blends at magnification of 200X.	69
Figure 4.12	Differential scanning calorimetry (DSC) curves comparison of PP/CR blends at different blend ratios.	70
Figure 4.13	Differential scanning calorimetry (DSC) curves comparison of RPP/CR blends at different blend ratios.	70
Figure 4.14	The effect of blend ratios on tensile strength of unvulcanized and dynamic vulcanized RPP/CR blends.	72
Figure 4.15	The effect of blend ratios on Young's modulus of unvulcanized and dynamic vulcanized RPP/CR blends.	73
Figure 4.16	The effect of blend ratios on elongation at break of unvulcanized and dynamic vulcanized RPP/CR blends.	74
Figure 4.17	Swelling percentage versus time of unvulcanized and dynamic vulcanized RPP/CR blends at different blend ratios.	75
Figure 4.18	Equilibrium swelling percentage versus blend ratios of unvulcanized and dynamic vulcanized RPP/CR blends at different blend ratios.	76
Figure 4.19	Scanning electron micrograph of tensile fracture surface of dynamic vulcanized RPP/CR (70/30) blends.	77
Figure 4.20	Scanning electron micrograph of tensile fracture surface of dynamic vulcanized RPP/CR (40/60) blends.	78
Figure 4.21	Comparison of differential scanning calorimetry (DSC) curves of unvulcanized and dynamic vulcanized RPP/CR blends at different blend ratios.	79
Figure 4.22	The effect of blend ratios on tensile strength of uncompatibilized and compatibilized RPP/CR blends.	81

Figure 4.23	The effect of blend ratios on Young's modulus of uncompatibilized and compatibilized RPP/CR blends.	82
Figure 4.24	The effect of blend ratios on elongation at break of uncompatibilized and compatibilized RPP/CR blends.	83
Figure 4.25	Swelling percentage versus time of uncompatibilized and compatibilized RPP/CR blends at different blend ratios.	84
Figure 4.26	Equilibrium swelling percentage versus blend ratios of uncompatibilized and compatibilized RPP/CR blends at different blend ratios.	85
Figure 4.27	Scanning electron micrograph of tensile fracture surface of compatibilized RPP/CR (70/30) blends.	86
Figure 4.28	Scanning electron micrograph of tensile fracture surface of compatibilized RPP/CR (40/60) blends.	86
Figure 4.29	Comparison of differential scanning calorimetry (DSC) curves of uncompatibilized and compatibilized RPP/CR blends at 40/60 blend ratios.	88
Figure 4.30	The effect of blend ratios on tensile strength of RPP/CR blends with and without MA.	90
Figure 4.31	The effect of blend ratios on Young's modulus of RPP/CR blends with and without MA.	91
Figure 4.32	The effect of blend ratios on elongation at break of RPP/CR blends with and without MA.	92
Figure 4.33	Swelling percentage versus time of RPP/CR blends with and without MA at different blend ratios.	93
Figure 4.34	Equilibrium swelling percentage versus blend ratios of RPP/CR blends with and without MA at different blend ratios.	94
Figure 4.35	Scanning electron micrograph of tensile fracture surface of RPP/CR (70/30) blends with MA.	95
Figure 4.36	Scanning electron micrograph of tensile fracture surface of RPP/CR (40/60) blends with MA.	95
Figure 4.37	Comparison of differential scanning calorimetry (DSC) curves of RPP/CR blends with and without MA at 40/60 blend ratios.	96

LIST OF TABLES

		PAGE
Table 3.1	Typical properties of polypropylene (PP) Grade S12232 G112.	52
Table 3.2	Properties of chloroprene rubber (CR) code B-30.	53
Table 3.3	Properties of maleic anhydride grafted polypropylene (MAPP) grade 426512.	54
Table 3.4	Properties of maleic anhydride (MA) grade M625.	54
Table 3.5	The formulation of PP/CR blends with different blend ratios.	55
Table 3.6	The formulation of RPP/CR blends with different blend ratios.	55
Table 3.7	The formulation of unvulcanized and dynamic vulcanized of RPP/CR blends.	56
Table 3.8	The formulation of uncompatibilized and compatibilized of RPP/CR blends with MAPP and MA.	57
Table 4.1	The melting temperature (T_m), enthalpy of fusion (ΔH_f) and crystallinity of blend (X_b) of PP/CR and RPP/CR blends at different blend ratios.	71
Table 4.2	The melting temperature (T_m), enthalpy of fusion (ΔH_f) and crystallinity of blend (X_b) of RPP/CR blends for unvulcanized and dynamic vulcanized at different blend ratios.	80
Table 4.3	The melting temperature (T_m), enthalpy of fusion (ΔH_f) and crystallinity of blend (X_b) of uncompatibilized and compatibilized RPP/CR blends at different blend ratios.	88
Table 4.4	The melting temperature (T_m), enthalpy of fusion (ΔH_f) and crystallinity of blend (X_b) of RPP/CR blends with and without MA at different blend ratios.	97

LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURES

1, 2-PB	1, 2-polybutadiene
AAc	Acrylic acid
ABS	Acrylonitrile butadiene styrene copolymer
ASTM	American Society for Testing and Material
BMI	M-phenylene-bis-maleimide
CBS	N-cyclohexylbenzothiazole-2-sulphenamide
CIIR	Chlorobutyl rubber
CPE	Chlorinated polyethylene
CR	Chloroprene rubber
DCP	Dicumyl peroxide
DMA	Dynamic Mechanical Analysis
DOP	Di-octyl phthalate
DSC	Differential scanning calorimetry
EBA	Poly(ethylene-co-butyl acrylate)
ENR	Epoxidized natural rubber
EOC	Ethylene octene copolymer
EOR	Ethylene-1-octene copolymer
EP	Epoxy
EPDM	Ethylene propylene diene terpolymer
EPM	Ethylene propylene copolymer
EPR	Ethylene propylene rubber
FTIR	Fourier Transform Infrared Spectroscopy

GMA	Glycidyl methacrylate
GTR	Ground tyre rubber powder
HDPE	High density polyethylene
HVA-2	<i>N,N'</i> - <i>m</i> -phenylenebismaleimide
LDPE	Low density polyethylene
LLDPE	Linear low density polyethylene
LNR-6	Liquid natural rubber
MA	Maleic anhydride
MAc	Maleic acid
MAPP	Maleic anhydride grafted polypropylene
MBS	2-morpholinothiobenzothiazole
MgO	Magnesium oxide
MNR	Maleated natural rubber
NBR	Acrylonitrile butadiene rubber
NR	Natural rubber
PA	Polyamide
PA6	Polyamide 6
PA12	Polyamide 12
PC	Polycarbonate
PE	Polyethylene
PEBAX	Copolymer ethylene propylene diene
PEO	Poly(ethylene-octene) copolymer
PET	Polyethylene terephthalate
POE	Polyethylene octene elastomer
POM	Polyoxymethylene

PP	Polypropylene
PS	Polystyrene
PTT	Poly(trimethylene terephthalate)
PUR	Polyurethane
PVC	Polyvinyl chloride
RPP	Recycled polypropylene
RR	Recycled rubber
RTR	Reclaimed tire rubber
SAN	Styrene acrylonitrile copolymer
SBS	Styrene butadiene styrene copolymer
SEBS	Styrene ethylene butylene styrene block copolymer
SEM	Scanning electron microscope
T _g	Glass transition temperature
T _m	Melting temperature
TEM	Transmission Electron Microscopy
TGA	Thermogravimetric Analysis
TMTD	Tetramethylthiuram disulfide
TMTM	Tetramethylthiuram monosulfide
TPEs	Thermoplastic elastomers
TPOs	Thermoplastic polyolefin blends
TPUs	Thermoplastic polyurethanes
TPVs	Thermoplastic vulcanizates
Tris	Trimethylolpropane methacrylate
WRP	Waste rubber powder
WTD	Waste tyre dust

X_b	Crystallinity of blend
ZnO	Zinc oxide
ΔH_f	enthalpy of fusion of blend

© This item is protected by original copyright

Pencirian dan Sifat Adunan-Adunan Polipropilena Kitar Semula (PKS)/Getah Kloroprena (GK)

ABSTRAK

Elastomer termoplastik adunan-adunan polipropilena kitar semula (PKS) dan getah kloroprena (GK) telah dikaji. Adunan-adunan polipropilena tulen (PP)/getah kloroprena telah digunakan untuk perbandingan. Adunan-adunan disediakan dengan menggunakan pencampur bilah-Z pada suhu 180°C dan kelajuan rotor pada 50 rpm. Kesan nisbah adunan-adunan ke atas sifat-sifat tensil, sifat-sifat pembengkakan, morfologi dan sifat terma juga telah dikaji. Didapati dengan meningkatnya kandungan GK di dalam adunan-adunan PP/GK dan PKS/GK telah meningkatkan pemanjangan pada takat putus dan indeks pembengkakan manakala kekuatan tensil, modulus Young dan penghabluran didapati berkurang. Adunan-adunan PP/GK telah menunjukkan sifat-sifat tensil dan terma yang lebih baik berbanding dengan adunan-adunan PKS/GK. Kajian morfologi adunan-adunan PP/GK menunjukkan interaksi antara muka yang lebih baik berbanding dengan adunan-adunan PKS/GK. Kesan pemvulkanan dinamik ke atas sifat-sifat adunan-adunan PKS/GK menunjukkan kekuatan tensil, pemanjangan takat putus, modulus Young dan penghabluran yang lebih tinggi tetapi peratus pembengkakan yang rendah. Pengserasi, maleik anhidrida polipropilena (MAPP) dan maleik anhidrida (MA) telah digunakan untuk meningkatkan sifat tensil adunan-adunan. Penambahan MAPP atau MA telah meningkatkan kekuatan tensil, modulus Young, pemanjangan pada takat putus dan penghabluran adunan-adunan. SEM mikrograf permukaan patahan tensil adunan-adunan PKS/GK dengan pemvulkanan dinamik, MAPP atau MA menunjukkan interaksi antara muka dan lekatan di antara GK dan PKS telah meningkat. Kehadiran MAPP atau MA di dalam adunan-adunan PKS/GK menunjukkan ketahanan terhadap bahan kimia yang lebih baik.

Characterization and Properties of Recycled Polypropylene (RPP)/Chloroprene Rubber (CR) Blends

ABSTRACT

The thermoplastic elastomer of recycled polypropylene (RPP) and chloroprene rubber (CR) blends were studied. Virgin polypropylene (PP)/chloroprene rubber blends were used as comparison. The blends were prepared by using Z-blade mixer at temperature 180°C and rotor speed of 50 rpm. The effect of blend ratios on tensile properties, swelling behaviour, morphology and thermal properties were investigated. It was found that increasing of CR content in PP/CR and RPP/CR blends increased the elongation at break and swelling percentage but decreased in tensile strength, Young's modulus and crystallinity. The PP/CR blends indicated higher tensile and thermal properties than RPP/CR blends. The morphology study of PP/CR blends showed better interfacial interaction as compared to RPP/CR blends. The effect of dynamic vulcanization on the properties of RPP/CR blends indicated higher tensile strength, elongation at break, Young's modulus and crystallinity but lower swelling percentage. The compatibilizers, maleic anhydride grafted polypropylene (MAPP) and maleic anhydride (MA) were used to enhance the tensile properties of blends. The addition of MAPP or MA has improved the tensile strength, Young's modulus, elongation at break and crystallinity of blends. The micrograph SEM of tensile fracture surface of RPP/CR blends with dynamic vulcanized, MAPP or MA showed the interfacial interaction and adhesion between CR and RPP has been improved. The presence of MAPP or MA in RPP/CR blends exhibited better chemical resistance.

CHAPTER 1

INTRODUCTION

1.1 Research Background

Nowadays, many new high performance products are manufactured by melt blending of common polymers. Polymer blends are one of the most interesting and useful classes of materials, which offer a convenient and less expensive alternative to develop new type of materials that can be tailor-made to meet specific requirements (Chakraborty et al., 2008a). Blending of polymers has been widely investigated as a simple and practical means to obtain new materials with novel properties. The blending of different polymer pairs usually gives rise to new materials with properties that cannot be achieved from the individual components. The many attractive mechanical characteristics of polymer blends have made it desirable to choose these materials over individual materials for numerous types of applications such as in automotive industries, explosives, and load-bearing components. As the use of polymer blends increase, an understanding of the mechanical behaviour of these materials becomes vital for creating innovative and economical designs for various components (Abu-Abdeen & Elamer, 2010).

Materials that combine elastomeric properties with many of the attributes of thermoplastics have been available to industry for over twenty years. They provide opportunities for polymeric materials to satisfy the requirements of designers and users of a wide range of products across a whole industry. Therefore, a number of research

works have been focused on enhancing properties of these materials for a specific application and for a better combination of properties. The thermoplastic elastomers (TPEs) based on rubber and plastic blends are kind of those materials. They combine the excellent processing characteristics of thermoplastic materials at high temperature, and a wide range of physical properties of conventional elastomers at room and service temperatures. TPEs materials are reprocessable, display and have economic advantages (Coran et al., 1998). The TPEs are materials consisting of a relatively high volume fraction of fully elastomeric domains in a continuous thermoplastic matrix. This morphological feature is produced by the process of vulcanizing a rubber component during its melt mixing with a thermoplastic resin (Asami & Nitta, 2004). TPEs have been gaining importance because of their wide range application in such fields as automotive parts, household appliances, electrical equipment, industrial supplies, food contact systems and medical apparatus (Rader, 2003).

The most well-known materials used to prepare TPEs are olefinic thermoplastics, such as epoxidized natural rubber (ENR)/polypropylene (PP) blends (Nakason et al., 2006a), natural rubber (NR)/low density polyethylene (LDPE) blends (Bhowmick et al., 2001) and NR/linear low density polyethylene (LLDPE) (Dahlan et al., 2002). NR/high density polyethylene (HDPE) blends have also produced interesting TPE materials (Nakason et al., 2006b). This type of blend combines the excellent processing characteristics of HDPE and the elastic properties of NR which can be used in automobile components and other industrial applications.

Thermoplastic elastomer based on polypropylene (PP) has received much attention over the years. Some elastomers such as ethylene propylene rubber (EPR), styrene butadiene styrene copolymer (SBS), butyl rubber, and ethylene propylene diene terpolymer (EPDM) have been introduced into PP to improve the impact and toughness

of PP (Tang et al., 2009). PP is considered to be the best choice for blending with elastomers due to its high softening temperature of about 150°C and the low glass transition temperature of the blend. The blending of PP with various elastomers has been done by many researchers. Awang et al., (2008) investigated the effect of latex modified waste tyre dust (WTD_{ML}) on tensile properties, swelling resistance, and morphology of PP/waste tyre dust (WTD) blends. They found that the presence of WTD_{ML} in the blends enhanced the tensile properties and swelling resistance of PP/WTD_{ML} blends, and the improvement in interfacial adhesion and dispersion of PP/WTD_{ML} blends.

PP is one of the most common thermoplastic polymers used for blending with elastomers. The use and demand of PP is increasing at a very fast pace. Indeed PP can be produced from low-cost petrochemical raw material, making it an inexpensive thermoplastic, relative to others, while showing good processability and reasonably high mechanical properties. Because of its excellent molding processability and good mechanical properties, PP has been widely used in automobile, household appliance and construction industry.

The improvement of physical and mechanical properties of PP based blends can be achieved by addition of rubbers or elastomers into it. Elastomers such as Chloroprene rubber (CR) or Neoprene are used to enhance the toughness and impact properties of PP. There are some advantages of CR which they have good inherent flame resistance, moderate resistance to oil and gasoline, excellent adhesion to fabrics and metals, very good resistance to weather ozone and natural aging, good resistance to abrasion and flex cracking and very good resistance to alkalis and acids (Long, 1985). CR is used in different applications such as for automotive parts, wire and cable jackets, general industrial parts, sponge and construction materials for buildings and public works.

Thermoplastics contribute to the total plastic consumption by roughly 80% and are used for typical plastics applications such as packaging but also in non-plastics applications such as textile fibres and coatings (Dewil et al., 2006). PP is one of the most visible forms of waste in landfills due to its chemically stabilized state for long service life and high volume-to-weight ratio. The presence of recycled PP has increased significantly for economic and environmental reasons in today's society (Brachet et al., 2008). It becoming a common procedure for the automotive as well as in the packaging industry. Thus, blends of recycled polypropylene (RPP) with elastomer would have some environmental advantages. The use of RPP in the blends can substitute the virgin synthetic thermoplastic matrix and the end product would be cheap. However, the recycled plastics have less desirable properties compared to the same articles manufactured from virgin materials. RPP has lower fracture properties (Aurrekoetxea et al., 2001) and heat ageing (Gahleitner, 2002) compared to virgin PP. Although the properties of RPP are lower than virgin PP, the idea is to enhance the properties of the RPP sufficiently for an intended technical application without losing the ecological and economic advantages of the recycled material. Navarro et al., (2003) have used the RPP toughened with various types of elastomers in their studies. They found that elastomer can improved the toughness without compromising the processability and recycling capabilities of the blends.

Generally, blending of thermoplastic and elastomer has led to an immiscible blend, phase separation, low interfacial adhesion and poor mechanical properties. In order to improve the compatibility of this immiscible polymer blend, the addition of one or more compatibilizers, such as block and graft copolymers were used to reduce interfacial tension, decrease the size of dispersed phase and provide specific interaction between two phases (Li et al., 2009).

In recent years, the common methods have been studied to improve the interfacial adhesion of blends included the use of maleic anhydride grafted polypropylene (MAPP) and grafting of maleic anhydride (MA). MAPP is a very effective compatibilizer that has been to improve the interfacial interaction between the components and mechanical properties of polymer blends by introducing the polar groups on the nonpolar PP backbone that leads to better interfacial adhesion. The novel technique for preparing maleic anhydride grafted PP has been reported by Qiu et al., (2005). The MAPP contributed to modification of polyolefins and gives the advantages of solventless, lower process temperature, energy efficient, low cost and easily running process which yields the high purity MAPP.

The purposes of MA grafting is either to achieve a polarity match or to introduce reaction sites (Elmaghor et al., 2004). Various elastomers such as CR, EPDM, EPR and NR can be used as polymer for the grafting of MA. Melt grafting of MA onto elastomer backbone has also been done by many researchers to improve the compatibility between non-polar elastomers. Jose, (2005) reported the effect of compatibilization by using MA on the blends of polyamide 12 (PA12)/styrene ethylene butylene styrene block copolymer (SEBS). They found that the morphology of compatibilized blends exhibited finer and more uniform rubber dispersion than the uncompatibilized blends because of the interfacial chemical reactions. The mechanical properties of PA12/maleic anhydride-grafted-SEBS (SEBS-g-MA) blends also were superior to those of PA12/SEBS blends.

Ismail & Suryadiansyah, (2002) have reported the comparison of mechanical properties of PP/NR and PP/recycle rubber (RR) blends. The tensile strength and Young's modulus decrease with increasing rubber content but elongation at break exhibit opposite trends for both blends. It was found that PP/RR blends have higher

mechanical properties than PP/NR blends. However, these blends are immiscible and these combinations are known to cause reductions in both strength and stiffness of the blends. They also have poor mechanical properties due to the weak physical and mechanical interactions between the phases. Thus, several studies were done to attain a technological compatibilization, improving the mechanical properties of the blends.

Dynamic vulcanization is a route to new TPEs, which have properties as good or even, in some cases, better than those of elastomeric block copolymers. This method describes the process of vulcanization of the elastomer during melt-mixing with a molten plastic (Soto-Oviedo & De Paoli, 2006). Elastomers are vulcanized to give a particulate vulcanized elastomer phase of stable domain morphology both during melt processing and subsequently. The effect of the dynamic vulcanization is to produce compositions which have improvements in permanent set, ultimate mechanical properties, fatigue resistance, melt strength and thermoplastic processability (Hernández et al., 2008). Dynamic vulcanization and addition of compatibilizers to the blends were done by several researchers to improve the blend performance. Awang et al., (2007) studied the effect of dynamic vulcanization on tensile properties of PP/waste tire dust (WTD) blends. They found that the dynamic vulcanization improve the tensile properties of the blends and promoted good adhesion between the PP matrix and WTD. Huang et al., (2002) have prepared a blend of EPDM and nylon via dynamic vulcanization. The effects of curing systems and compatibilizers on the mechanical properties of EPDM/nylon blends were investigated. They found that EPDM/nylon blends using sulfur as curative has higher tensile strength and elongation at break than that of blends using phenolic resin or peroxide as curatives. The compatibilized EPDM/nylon blends with MA grafted EPR has a better performance compared with other compatibilizers containing acid group. Nakason et al., (2006c) used MAPP in