

**EFFECTS OF CRUDE PALM OIL ON THE PHYSICO-CHEMICAL
PROPERTIES OF POLYETHYLENE BLOWN FILM**

By

MIN MIN AUNG

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in
Fulfilment of the Requirement for the Degree of Master of Science**

April 2006

Dedication

With gratitude for their love, support, and guidance,

I dedicate this thesis to my parents,

U Nay Myo Aung and Daw Ah Mar Sein

**Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment
of the requirement for the degree of Master of Science**

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Chairman : Chuah Teong Guan, PhD

Faculty : Engineering

The influence of small amounts of crude palm oil (CPO) content on the physical and chemical properties of high density polyethylene (HDPE) and linear low-density polyethylene (LLDPE) have been investigated. HDPE and LLDPE containing, 2, 3 and 5% CPO were prepared in a twin-screw extruder. Then, films of 0.2mm thickness were produced by using blown film technique. The melting point of CPO is 35.65°C and melting point of PE is 130-140°C in HDPE and 85-125°C in LLDPE. Thermal observation by Differential Scanning Calorimetry (DSC) is not significant in melting and crystallisation. Similar observation was also presented in storage modulus, $\tan \delta$ and loss modulus of Dynamic Mechanical Analysis (DMA) results.

The improvement of tensile strength and elongation at break showed that the enhancement in toughness of the polymers in the addition of CPO. A gradual increase in impact strength of HDPE with the CPO content further supported above

notation. The enhancement in the physical properties in the presence of CPO is believed to be attributed to the increased chain mobility of the polymer along with improved orientation strengthening in HDPE and LLDPE. Evidence from Scanning Electron Micrographs (SEM) were also used to support this contention. However, the decline in impact strength of LLDPE with the addition of CPO is associated with the formation of defects in amorphous phase of LLDPE.

With increasing of CPO addition, viscosity is increased at the low shear rate in rheological examination. Melt Flow Index (MFI) value is increased with the incremental of CPO addition. FT-IR analysis shows that almost same spectra of modified PE with control. The results indicate that no chemical reaction occurred between PE and CPO.

Abstrak tesis ini dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

KAJIAN TERHADAP PENGUBAHSUAIAN POLITELINE MENGGUNAKAN MINYAK KELAPA SAWIT MENTAH

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Kajian mengenai pengaruh kandungan minyak sawit mentah (CPO) dalam kuantiti yang kecil terhadap keadaan fizikal dan ciri-ciri kimia politeline ketumpatan tinggi (HDPE) dan politeline ketumpatan rendah (LLDPE) telah dijalankan. HDPE dan LLDPE yang mengandungi 2, 3 dan 5 % CPO disediakan di dalam ‘twin-screw extruder’. Kemudian, filem-filem dengan ketebalan 0.2mm dihasilkan dengan melalui teknik pencairan filem. Takat lebur bagi CPO ialah 35.65°C manakala, bagi PE pula ialah 130-140°C di dalam HDPE dan 85-125°C di dalam LLDPE. Pemerhatian dari segi haba pula tidak signifikan untuk peleburan dan pengkristalan. Pemerhatian yang sama turut ditunjukkan dalam modulus simpanan, $\tan \delta$ dan modulus pengurangan dalam keputusan analisis mekanikal dinamik (DMA). Peningkatan dalam kekuatan regangan dan pemanjangan pada titik penamat dengan penyelarasan penurunan telah meningkatkan tahap

kekerasan polimer melalui penambahan CPO. Manakala, penurunan secara berperingkat dalam kesan kekuatan HDPE yang mengandungi CPO telah menyokong 'above notation'. Peningkatan ciri-ciri fizikal dengan kehadiran CPO dipercayai menyumbang kepada peningkatan pergerakan rantaian polimer selaras dengan perkembangan orientasi kekuatan HDPE dan LLDPE. Bukti-bukti daripada pengimbas Mikrograf Elektron juga turut digunakan untuk menyokong pendapat ini. Walau bagaimanapun, penurunan dalam kesan kekuatan LLDPE yang mengandungi CPO adalah sama dengan pembentukan kerosakan dalam fasa amorphous LLDPE.

Indeks Aliran Lebur (MFI) berkurangan dengan peningkatan kandungan CPO. Kelikatan yang berkurangan dengan kadar sekata pula menunjukkan tahap kelinciran CPO. Ini membuktikan bahawa kemampuan pemprosesan PE adalah meningkat dengan penambahan CPO. Sifat-sifat rheologikal juga sepadan dengan perubahan morfologi terhadap politeline yang telah dimodifikasi. Aliran ciri-ciri CPO/ PE pula tidak menunjukkan perubahan sebagaimana yang dijangka dengan mengambil kira CPO sebagai agen penyesuaian. Begitu juga keputusan analisis daripada Fourier Transform Infrared (FTIR) yang menunjukkan secara relatifnya interaksi intermolekular yang kuat antara CPO dan PE adalah wujud dalam filem PE termodifikasi.

ACKNOWLEDGEMENTS

I would like to express my sincere and deep gratitude to my Supervisor Dr.Chuah Teong Guan (UPM) and Dr.Chantara Theyy Ratnam (MINT) who provided considerable invaluable insights and comments to help me enhance the quality to my work. Without their patient support, enlighten guidance, it is impossible for me to complete this long journey. Thanks for All their efforts and precious time for my research.

I would like also thanks to members of the supervisory committees, Dr. Suraya Abdul. Rashid (UPM) and Mr.Wan Hasamudin Wan Hassan (MPOB), for their helpful advice and guidance during the course of Research and I wish to thank

I would like to thanks to lab supervisor and staff of MINT and PRSS, especially Ms.Normawati Samsudin, Mr.Zulkifli b Ahamid from PRSS and Mr.Wan Ali Wan Yusof, Mr. Zahid Abdullah from MINT.

Finally, I dedicate this thesis to my beloved family, in particular, my parents, without their love, support and encouragement, it would not be possible for me.


I certify that an Examination Committee has met on 13 April 2006 to conduct the final examination of Min Min Aung on her Master of Science entitled "Effect of Crude Palm Oil on the physio-chemical properties of polyethylene blown film" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

MIN MIN AUNG

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TABLE OF CONTENTS

	Page
DEDICATION	
ABSTRACT	ii
ABSTRAK	iii
ACKNOWLEDGEMENTS	v
APPROVAL	vi
DECLARATION	viii
LIST OF TABLES	xi
LIST OF FIGURES	xii
LIST OF ABBREVIATIONS	xiv
LIST OF NOTATIONS	xvi
CHAPTER	
1 INTRODUCTION	
1.1 Background of study	1
1.2 Modified polyethylene properties with fillers	3
1.3 The Objectives of the study	5
2 LITERATURE REVIEW	
2.1 Introduction	7
2.2 Polyolefin films	
2.2.1 Polyolefin films	
2.2.2 LLDPE and HDPE films	7
2.3 Modified Polyethylene	11
2.3.1 Palm Oil modified polyolefin	
2.3.2 Polyethylene modified Palm Oil's	
2.4 Review of prior researches	15
2.5 Palm oil polymers	17
2.6 Summary	11 19
3 METHODOLOGY	
3.1 Introduction	21
3.2 Materials and samples preparation	22
3.2.1 Formulations	23
3.2.2 Compounding procedure	23
3.2.3 Preparation of blown film	25
3.2.4 Compression moulding	26
3.2.5 Preparation of Izod impact test specimens	27
3.3 Thermal properties analysis	27

3.3.1	Differential Scanning Calorimetry (DSC)	27
3.3.2	Dynamic Mechanical Analysis (DMA)	28
3.4	Mechanical properties tests	29
3.4.1	Tensile strength	29
3.4.2	Impact strength	30
3.5	Morphological examination	31
3.5.1	Scanning Electron Microscopy (SEM)	31
3.6	Rheological determination	31
3.6.1	Melt Flow Index	32
3.7	Physical and Chemical Analysis	32
3.7.1	Density measurements	32
3.7.2	Evaluation of FT-IR	33
4	RESULTS AND DISCUSSIONS	
4.1	Thermal properties analysis	34
4.2	Dynamic Mechanical Analysis (DMA)	38
4.2.1	Effect of temperature on storage modulus (E')	39
4.2.2	Effect of temperature on tan δ	40
4.3	Tensile strength	42
4.3.1	Elongation at break	45
4.3.2	Modulus of elasticity	47
4.4	Impact strength	48
4.5	Morphological observation	51
4.6	Rheology	
4.6.1	Flow properties	55
4.6.2	Rheological properties	56
4.7	Physical and Chemical analysis	
4.7.1	Determination of modified polymer density	59
4.7.2	FTIR	60
5	CONCLUSION	62
6	RECOMMENDATIONS FOR FUTURE WORK	65
	REFERENCES	66
	APPENDICES	70
	BIODATA OF THE AUTHOR	74

LIST OF TABLES

Table	Page
3.1 Characteristics of polyethylene used in this study	22
3.2 Properties of CPO used in this study	22
3.3 (a) Extrusion parameter of CPO:LLDPE at 170/180/180°C	24
3.3 (b) Extrusion parameter of CPO:HDPE at 170/180/180°C	24
3.4 (a) Blowing parameter of CPO:LLDPE at 170/180/180°C	25
3.4 (b) Blowing parameter of CPO:HDPE at 170/180/180°C	26
4.1 Effect of CPO on the melting temperature (T_m), degree of crystallinity (w_c), crystallinity temperature (T_c) and density (ρ) of HDPE	35
4.2 Effect of CPO on the melting temperature (T_m), degree of crystallinity (w_c), crystallinity temperature (T_c) and density (ρ) of LLDPE	35
4.2 Effect of CPO loading on the ratio of MD to TD	43
4.3 Effect of CPO on the density of HDPE and LLDPE	59

LIST OF FIGURES

Figure	Page
3.1 Flow Chart of compounding PE and CPO	27
4.1 Effect of CPO on thermal conductivity of HDPE and LLDPE.	36
4.2 The crystallization graph of HDPE in the presence of 0, 2, 3 and 5% of CPO	37
4.3 The melting graph of HDPE in the presence of 0, 2, 3 and 5% of CPO	37
4.4 The crystallization graph of LLDPE in the presence of 0, 2, 3 and 5% of CPO	38
4.5 The melting graph of LLDPE in the presence of 0, 2, 3 and 5% of CPO	38
4.6 Effect of CPO on the storage modulus of HDPE : (a) 0% CPO content (b) 5% CPO content	39
4.7 Effect of CPO on the storage modulus of LLDPE : (a) 0% CPO content (b) 5% CPO content	39
4.8 Effect of CPO on the $\tan \delta$ of HDPE : (a) 0% CPO content (b) 5% CPO content	40
4.9 Effect of CPO on the $\tan \delta$ of LLDPE : (a) 0% CPO content (b) 5% CPO content	41
4.10 Effect of CPO on the loss modulus of HDPE : (a) 0% CPO content (b) 5% CPO content	41
4.11 The loss modulus of LLDPE:CPO composite. : (a) 0% CPO content (b) 5% CPO content	42
4.12 Effect of CPO on the T_s of LLDPE	44

4.13	Effect of CPO on the Ts of HDPE	44
4.14	Effect of CPO on the Eb of LLDPE	46
4.15	Effect of CPO on the Eb of HDPE	46
4.16	Effect of CPO on the Modulus of LLDPE	47
4.17	Effect of CPO on the Modulus of HDPE	47
4.18	Effect of CPO on the dart drop impact strength of HDPE and LLDPE	49
4.19	Effect of CPO on the Izod impact strength of HDPE and LLDPE	50
4.20	SEM micrograph of HDPE and LLDPE film fracture part at 100% elongation (Magnification 10,000x)	52
4.21	SEM micrograph of HDPE and LLDPE film surface in the presence 2%CPO : samples were stretched 500% in MD (Magnification 10,000x)	53
4.22	SEM micrograph of HDPE and LLDPE film surface in the presence 3%CPO : samples were stretched 500% in MD (Magnification 10,000x)	54
4.23	SEM micrograph of HDPE and LLDPE film surface in the presence 5%CPO : samples were stretched 500% in MD (Magnification 10,000x)	55
4.24	Effect of CPO on the MFI of LLDPE and HDPE.	56
4.25	Dependence of viscosity on shear rate for HDPE	57
4.26	Dependence of viscosity on shear stress for HDPE	57
4.27	Dependence of shear stress on shear rate for HDPE	57
4.28	Dependence of viscosity on shear rate for LLDPE	58
4.29	Dependence of viscosity on shear stress for LLDPE	58
4.30	Dependence of shear stress on shear rate for LLDPE	59

4.5.2.1 IR spectra of PE:CPO (a)0%CPO:LLDPE(b)5%CPO:LLDPE	61
4.5.2.2 IR spectra of PE:CPO (a)0%CPO:HDPE(b)5%CPO:HDPE	62

LIST OF ABBREVIATIONS/ NOTATIONS

CPO	Crude palm oil
PE	Polyethylene
LDPE	Low density polyethylene
LLDPE	Linear low density polyethylene
HDPE	High density polyethylene
DMA	Dynamic mechanical analysis
DSC	Differential scanning calorimetry
MD	Machine direction
TD	Transverse direction
SEM	Scanning electron microscopy
Ts	Tensile strength
Eb	Elongation at break
MFI	Melt Flow Index
SCB	Short chain branching
UTM	Instron Universal Testing Machine
ECSR	Environmental Stress-Crack Resistance
MWD	Molecular weight distribution
HMW	High molecular weight
LCB	Long chain branch
EPOP	Epoxidized palm oil and palm oil products
ESBO	Epoxidized soyabean oil

PVC	Polyvinyl chloride
PP	Polypropylene
OTR	Oxygen transmission rate
WVTR	Water vapour transmission rate
PS	Polystyrene
MPE	Maleated polyethylene
ASTM	American society of testing and materials
DOBI	Deterioration of bleachability index
VLDPE	Very low density polyethylene
EVA	Ethylene vinyl acetate
FFB	Fresh fruit bunches
DOBI	Deterioration of bleach ability index
LVDT	High sensitivity displacement detector
DBS	Distance between the supports
FTIR	Fourier transform infrared spectra
WS	Water sorption

T_c	Crystallisation temperature	$^{\circ}\text{C}$
T_m	Melting point	$^{\circ}\text{C}$
w_c	Thermal conductivity	$\text{W/m } ^{\circ}\text{C}$
ρ_a	Density of amorphous phase	kg/m^3
ρ_c	Density of crystalline phase	kg/m^3
ρ	Density of polymer	kg/m^3
E'	Storage modulus	Pa
E''	Loss modulus	Pa
T_g	Glass transition temperature	$^{\circ}\text{C}$
$M50$	The dart drop impact weight	g
M_o	The lowest missile weight	g
D_w	Uniform weight decrement/ increment	g
A/N	Sum of number of failure occurred at a specified mass multiply by the number of mass increment and sum of failed specimen respectively	