

POLYSTYRENE GRAFTED WITH BIOCOMPATIBLE POLYMER

Nitibodee Sukjaroen

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By: Nitibodee Sukjaroen
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Thesis Advisor: Assoc. Prof. Rathanawan Magaraphan

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Nantaya Yanumet.

College Director

(Assoc. Prof. Nantaya Yanumet)

Thesis Committee:

R. M.

(Assoc. Prof. Rathanawan Magaraphan)

Nantaya Yanumet.

(Assoc. Prof. Nantaya Yanumet)

M. N.

(Asst. Prof. Manit Nithitanakul)

ABSTRACT

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Polystyrene, densely grafted with poly(DL-lactide), poly(ϵ -caprolactone) or poly(ϵ -caprolactam) in the benzene ring; i.e. PS-g-PLA, PS-g-PCL, and PS-g-Nylon6 respectively, was synthesized by a "grafting-from" method using polystyrene-hydroxylated precursors as macroinitiators for ring-opening polymerization of DL-lactide, ϵ -caprolactone, and ϵ -caprolactam. The wt% monomer feed ratios (PS:comonomer) were 1:1, 1:2, 1:3. All synthesized graft copolymers were structurally characterized by ^1H and ^{13}C NMR, HATR/FTIR, UV-Vis spectroscopy and GPC. PS-g-PLA had the highest molecular weight followed by PS-g-PCL, and PS-g-Nylon6, respectively. Grafting percentage was studied by ^1H NMR, weighing and TGA-DTA. The average grafting length was calculated from ^1H NMR results. Furthermore, thermal properties were detected by TG-DTA, DMA and DSC. Solubility of the copolymers in various solvents, water, acetic acid (pH 4), and 0.1 wt% aqueous salt solution was also determined. Higher monomer feed ratio enhanced molecular weight, degradation content, glass transition temperature and melting temperature but lowered the crystallinity and thus the copolymers became softer.

บทคัดย่อ

นิติบดี สุขเจริญ: การสังเคราะห์พอลิสไตรีนแบบกราฟด้วยพอลิเมอร์ชีวภาพ (Polystyrene grafted with biocompatible polymer) อ. ที่ปรึกษา: รศ. ดร. รัตนาวรรณ มกรพันธุ์ 139 หน้า ISBN 974-9937-16-3

การกราฟท์พอลิสไตรีนด้วย พอลิ ดีแอล-แลคไทด์ หรือ พอลิคาโปแลคโตน หรือ พอลิคาโปรแลคแทม บนวงเบนซีน (ใช้สัญลักษณ์แทนด้วย PS-g-PLA, PS-g-PCL, และ PS-g-Nylon6 ตามลำดับ) สังเคราะห์ด้วยวิธีกราฟดิ้งฟอร์ม โดยใช้พอลิสไตรีนไฮดรอกซิลเลตเป็นสารตั้งต้นที่มีหมู่ฟังก์ชันพร้อมที่จะก่อให้เกิดการพอลิเมอไรซ์แบบแตกวงของ ดีแอล-แลคไทด์, คาโปรแลคโตน, และ คาโปรแลคแทม ในกระบวนการสังเคราะห์นี้ใช้อัตราส่วนของมอนอเมอร์โดยน้ำหนัก (พอลิสไตรีน ต่อ โคมอโนเมอร์) ได้แก่ 1 ต่อ 1, 1 ต่อ 2, และ 1 ต่อ 3 ตามลำดับ ^1H และ ^{13}C NMR, HATR/FTIR, UV-Vis spectroscopy และ GPC ใช้ในการตรวจสอบและยืนยันโครงสร้างของกราฟโคพอลิเมอร์ที่สังเคราะห์ได้ จากการวิเคราะห์พบว่า PS-g-PLA ที่สังเคราะห์ได้จะมีค่าน้ำหนักต่อโมเลกุลสูงกว่า PS-g-PCL และ PS-g-Nylon6 ในอัตราส่วนเดียวกัน ตามลำดับ จำนวนการกราฟดิ้งเป็นร้อยละคำนวณได้จากหลายวิธีด้วยข้อมูลจาก ^1H NMR, น้ำหนักที่ชั่งได้จริง, และ TG-DTA ความยาวของสายกราฟพอลิเมอร์คำนวณจากผลของ ^1H NMR นอกจากนี้สมบัติทางความร้อนสามารถวิเคราะห์ได้ด้วยเครื่องมือ TG-DTA, DMA, และ DSC ทั้งนี้ยังได้ศึกษาสมบัติการละลายของโคพอลิเมอร์ด้วยตัวทำละลายหลายชนิด ได้แก่ น้ำ กรดแอสซิดิก (pH4), และ น้ำเกลือคิดเป็นร้อยละ 0.1 โดยน้ำหนัก อัตราส่วนที่เพิ่มขึ้นของมอนอเมอร์ที่ก่อให้เกิดสายกราฟพอลิเมอร์ จะมีผลต่อน้ำหนักโมเลกุล, ปริมาณการสลายตัวของโคพอลิเมอร์, อุณหภูมิสถานะคล้ายแก้ว และ อุณหภูมิการหลอมเหลว ทั้งนี้ยังส่งผลต่อการลดลงของปริมาณผลึก ดังนั้นสมบัติทางกายภาพของสารที่แสดงให้เห็น คือ พอลิเมอร์จะอ่อนตัวได้มากขึ้น

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TABLE OF CONTENTS

	PAGE
Title Page	i
Abstract (in English)	iii
Abstract (in Thai)	iv
Acknowledgements	v
Table of Contents	vi
List of Tables	ix
List of Figures	x
Abbreviations	xii

CHAPTER

I	INTRODUCTION	1
II	BACKGROUND AND LITERATURE REVIEW	4
III	EXPERIMENTAL	9
	3.1 Materials	9
	3.1.1 Reagent	9
	3.1.2 Starting Polymer	9
	3.2 Methodology	9
	3.2.1 Synthesis of Ring-Acylated Polystyrene	9
	3.2.2 Synthesis of Polystyrene Ring Substituted with 1-Hydroxypropyl Group	10
	3.2.3 Synthesis of Polystyrene-Graft -Poly(ϵ -caprolactone)	10
	3.2.4 Synthesis of Polystyrene-Graft -Poly(DL-lactide)	10
	3.2.5 Synthesis of Polystyrene-Graft-Polycaprolactam	11
	3.3 Equipment and Characterization	
	3.3.1 NMR	11
	3.3.2 FTIR/HATR Spectroscopy	11

CHAPTER	PAGE
3.3.3 Differential Scanning Calorimetry	12
3.3.4 UV-Vis Spectroscopy	12
3.3.5 Gel Permeation Chromatography	12
3.3.6 Total Organic Carbon Analyzer	13
3.3.7 Thermal Gravimetry - Dynamic Temperature Analysis	13
3.3.8 Dynamic Mechanical Analysis	13
3.3.9 Solubility	13
IV POLYSTYRENE GRAFTED WITH BIOCOMPATIBLE POLYMERS	16
Abstract	16
Introduction	16
Experimental	18
Results and Discussion	
Acylation	23
Reduction	24
Polystyrene Grafted with Poly(ϵ -caprolactone), Polycaprolactam, and Poly(DL-lactide)	25
The Grafting Percentage of the Copolymers	28
Absorption Properties of the Graft Copolymers	31
Solubility	33
Thermal Properties of the Grafting Copolymers	36
Conclusions	40
References	41
V CONCLUSIONS AND RECOMMENDATIONS	90
REFERENCES	93

CHAPTER		PAGE
APPENDICES		
Appendix A	Standard curve and sample's curve of GPC (room temp.)	97
Appendix B	Standard curve of GPC (water)	111
Appendix C	NMR spectrum of graft copolymer and precursor polymer from paper	112
Appendix D	NMR spectrum of graft copolymer and precursor polymer from ChemDraw Ultra 8.0 program	116
Appendix E	NMR spectrum of nitrobenzene, PCL, PLA, and Nylon6 from ChemDraw Ultra 8.0 program	126
Appendix F	Calculation of grafting percentage and the average length of grafting polymer	133
Appendix G	UV-Vis absorption spectrum of nitrobenzene	136
Appendix H	Table of wavelength absorption and observed color of compound	135
Appendix I	Degradation of side chain polymer	136
Appendix J	TG-DTA curve of PS	138
CURRICULUM VITAE		139

LIST OF TABLES

TABLE		PAGE
CHAPTER IV		
4.1	Molecular weights of polymers were characterized by GPC (rate 1 ml/min)	81
4.2	Grafting ratio calculated from TGA-DTA data in comparison to grafting ratio determined by weight and number of protons from ¹ H NMR	82
4.3	Length and number of grafting chain polymers calculated by ¹ H NMR spectrum	84
4.4	T _m , T _d , ΔH _m of T _m , ΔH _d of T _d from DSC results and solubility in chloroform	85
4.5	Total organic carbon content of the graft copolymers dissolved in water over night	86
4.6	Total organic carbon content in 0.1%wt salt water from the copolymer dissolved over night	87
4.7	The retention time and molecular weight of dissolved polymer in water at room temperature (over night) with Gel Permeation Chromatography (rate 0.5 ml/min)	88
4.8	Temperature of degradation, weight loss percentage and total residue percentage of copolymers were characterized by TG-DTA at 50-600 °C	89

LIST OF FIGURES

FIGURE	PAGE
CHAPTER II	
2.1 Grafting method.	5
CHAPTER III	
3.1 Synthesis method.	15
CHAPTER IV	
4.1 ^1H and ^{13}C NMR spectra of ring-acylated polystyrene.	45
4.2 The FTIR spectra of ring-acylated polystyrene (polymerA) and polystyrene ring substituted with 1-hydroxypropyl group (polymer B).	46
4.3 ^1H and ^{13}C NMR spectra of polystyrene ring substituted with 1-hydroxypropyl group.	47
4.4 Absorption spectra of the starting polymers and copolymers by HATR.	48
4.5 ^1H and ^{13}C NMR spectra of PS-g-PCL (ratio 1:1).	49
4.6 ^1H and ^{13}C NMR spectra of PS-g-PCL (ratio 1:2).	50
4.7 ^1H and ^{13}C NMR spectra of PS-g-PCL (ratio 1:3).	51
4.8 ^1H and ^{13}C NMR spectra of PS-g-PLA (ratio 1:1).	52
4.9 ^1H and ^{13}C NMR spectra of PS-g-PLA (ratio 1:2).	53
4.10 ^1H and ^{13}C NMR spectra of PS-g-PLA (ratio 1:3).	54
4.11 ^1H and ^{13}C NMR spectra of PS-g-Nylon6 (ratio 1:1).	55
4.12 ^1H and ^{13}C NMR spectra of PS-g-Nylon6 (ratio 1:2).	56
4.13 ^1H and ^{13}C NMR spectra of PS-g-Nylon6 (ratio 1:3).	57
4.14 TG-DTA spectra of PS-g-PCL in ratio 1:1.	58
4.15 TG-DTA spectra of PS-g-PCL in ratio 1:2.	59
4.16 TG-DTA spectra of PS-g-PCL in ratio 1:3.	60
4.17 TG-DTA spectra of PS-g-PLA in ratio 1:1.	61

FIGURE	PAGE
4.18 TG-DTA spectra of PS-g-PLA in ratio 1:2.	62
4.19 TG-DTA spectra of PS-g-PLA in ratio 1:3.	63
4.20 TG-DTA spectra of PS-g-Nylon6 in ratio 1:1.	64
4.21 TG-DTA spectra of PS-g-Nylon6 in ratio 1:2.	65
4.22 TG-DTA spectra of PS-g-Nylon6 in ratio 1:3.	66
4.23 The UV absorption curves of PS, polymer A and B.	67
4.24 The UV absorption curves of PS-g-PCL.	68
4.25 The UV absorption curves of PS-g-PLA.	69
4.26 The UV absorption curves of PS-g-Nylon6.	70
4.27 GPC curves of the water-dissolved polymer that PS-g-PCL was dissolved over night.	71
4.28 GPC curves of the water-dissolved polymer that PS-g-PLA was dissolved over night.	72
4.29 GPC curves of the water-dissolved polymer that PS-g-Nylon6 was dissolved over night.	73
4.30 The temperature of glass transition curves: PS, polymer A, polymer B.	74
4.31 The DSC curves of PS-g-PCL in ratio 1:1, 1:2, and 1:3.	75
4.32 The DSC curves of PS-g-PLA in ratio 1:1, 1:2, and 1:3.	76
4.33 The DSC curves of PS-g-Nylon6 in ratio 1:1, 1:2, and 1:3.	77
4.34 DMA curves of PS-g-PLA in ratio 1:1 by compression mode (30-130 °C).	78
4.35 DMA curves of PS-g-PLA in ratio 1:2 by compression mode (30-130 °C).	79
4.36 DMA curves of PS-g-PLA in ratio 1:1 by compression mode (30-130 °C).	80

ABBREVIATIONS

PS	Polystyrene
PS cut	Polystyrene chains were cut by Dicumyl peroxide 0.5% (w/w)
PCL	Poly(ϵ -caprolactone)
PLA	Poly(DL-lactide)
PS-g-PCL	Polystyrene-graft-poly(ϵ -caprolactone)
PS-g-PLA	Polystyrene-graft-poly(DL-lactide)
PS-g-Nylon 6	Polystyrene-graft-polycaprolactam
Polymer A	Ring-acylated polystyrene
Polymer B	Polystyrene ring substituted with 1-hydroxypropyl group
Capro11	Polystyrene-graft-poly(ϵ -caprolactone) in ratio 1 to 1 (PS: ϵ -caprolactone)
Capro12	Polystyrene-graft-poly(ϵ -caprolactone) in ratio 1 to 2 (PS: ϵ -caprolactone)
Capro13	Polystyrene-graft-poly(ϵ -caprolactone) in ratio 1 to 3 (PS: ϵ -caprolactone)
Lactide11	Polystyrene-graft-poly(DL-lactide) in ratio 1 to 1 (PS: DL-lactide)
Lactide12	Polystyrene-graft-poly(DL-lactide) in ratio 1 to 2 (PS: DL-lactide)
Lactide13	Polystyrene-graft-poly(DL-lactide) in ratio 1 to 3 (PS: DL-lactide)
Nylon11	Polystyrene-graft-polycaprolactam in ratio 1 to 1 (PS: caprolactam)
Nylon12	Polystyrene-graft-polycaprolactam in ratio 1 to 2 (PS: caprolactam)
Nylon13	Polystyrene-graft-polycaprolactam in ratio 1 to 3 (PS: caprolactam)
D.S.	Degree substituted

T_d	Decomposition temperature
T_g	Glass transition temperature
T_m	Melting temperature
ΔH_m	Melting enthalpy (Heat of fusion)
ΔH_d	Degradation enthalpy (Heat of degradation)
ΔH	Enthalpy
ΔS	Entropy