SYNTHESIS AND CHARACTERIZATION OF POLY(*P*-BENZAMIDE) FOR ELECTRORHEOLOGICAL FLUIDS

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ABSTRACT

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The particle dispersion type of electrorheological (ER) fluids, typically composed of small particles dispersed in a nonconducting liquid, are fascinating materials whose structure and rheological properties can be dramatically altered by the application of an external electric field. In this study, poly(*p*-benzamide) (PBA) particles, synthesized by the direct polycondenzation of *p*-aminobenzoic acid (*p*-ABA), were used as the dispersed phase and silicone oil as the medium. PBA were successfully synthesized to yield different molecular weights by changing the types of solvent and metal halide, and the amount of the phosphorus compound used. Thermal analysis indicates that the PBA are thermally stable up to around 500^0C. PBA of 3,900 and 11,000 g/mol form nematic liquid crystal (LC) phases in 4%LiCl/DMAc and 4%LiCl/NMP solvents at very low concentration compared to other lyotropic LC polymers. Successful study of ER behavior of the PBA solution in the LC state was not possible due to electrolytic reaction at the electrodes. Particulate dispersion of PBA in silicone oil was found to exhibit a pronounced ER response. In the linear viscoelastic region, there is a critical electric field strength for the transition from liquid to solid state. The magnitude of the ER effect in the linear viscoelastic region is larger than that in the nonlinear due to smaller deformation of ER-induced network structures.

บทคัดย่อ

สุฑาทิพย์ ลิ้มสุวรรณ : การสังเคราะห์และ วิเคราะห์ พอลิพาราเบนซาไมด์สำหรับของไหลอิเล็กโตรรีโอโลจิคอล (Synthesis and Characterization of Poly(*p*-benzamide) for Electrorheological Fluids) อาจารย์ที่ปรึกษา : ศ. ดร. อเล็กซานเดอร์ เอ็ม จิมมี่สัน (Prof. Alexander M. Jameison) และ รศ.ดร. อนุวัฒน์ ศิริวัฒน์ 153 หน้า ISBN 974-346-250-3

ของไหลอิเล็กโตรรีโอโลจิคอลชนิดสารแขวนลอย ประกอบด้วย อนุภาคขนาดเล็กกระจายตัวอยู่ในตัวกลางซึ่งไม่นำไฟฟ้า ของไหลนี้มีคุณสมบัติพิเศษ คือ เมื่อได้รับการเหนี่ยวนำจากสนามไฟฟ้า อนุภาคจะมีการเรียงตัวเป็นโครงสร้างที่มีลักษณะเป็นสายโซ่ในทิศทางขนานกับทิศทางของสนามไฟฟ้า ซึ่งอนุภาคในสายโซ่เหล่านี้ยึดติดกันด้วยแรงไฟฟ้าสถิตย์ ทำให้สมบัติทางวิทยากระแสมีการเปลี่ยนแปลง ในการทดลองนี้ใช้อนุภาคพอลิพาราเบนซาไมด์กระจายตัวอยู่ในน้ำมันซิลิโคน จากการศึกษาพบว่า พอลิพาราเบนซาไมด์สามารถสังเคราะห์ได้น้ำหนักโมเลกุลที่แตกต่างกันโดยการเปลี่ยนชนิดของตัวทำละลายและเกลือของโลหะ และปริมาณของฟอสฟอรัสที่ใช้ พอลิพาราเบนซาไมด์มีความเสถียรต่อความร้อนถึงอุณหภูมิประมาณ 500 องศาเซลเซียส และ สามารถสร้างลิควิดคลิสตรอลได้ที่ความเข้มข้นต่ำมาก การศึกษาสมบัติทางวิทยากระแสของสารละลายพอลิพาราเบนซาไมด์ในสภาวะลิควิดคลิสตรอลไม่ประสบความสำเร็จ เนื่องจากเกิดปฏิกิริยาไฟฟ้าเคมีขึ้นที่ขั้วไฟฟ้า สมบัติทางวิทยากระแสที่ได้จากพอลิพาราเบนซาไมด์ในสภาวะสารแขวนลอย พบว่า ในช่วงความเครียดต่ำมีความแรงสนามไฟฟ้าที่เป็นจุดวิกฤตในการเปลี่ยนรูปสารจากสถานะของเหลวไปเป็นของแข็ง ในช่วงความเครียดต่ำลอสมอดุลัสมีค่ามากกว่าในช่วงความเครียดสูง เนื่องจากโครงสร้างสายโซ่ของอนุภาคถูกทำลายน้อยกว่า

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TABLE OF CONTENTS

PAGE

Title Page ii

Abstract (in English) iii

Abstract (in Thai) iv

Acknowledgements v

Table of Contents vi

List of Tables ix

List of Figures x

CHAPTER

I INTRODUCTION 1

1.1 Background 1

1.1.1 What are Electrorheological Fluids? 1

1.1.2 Desired Properties of ER Fluids 2

1.1.3 The ER Phenomena of Particle Dispersion 4

1.1.4 Liquid crystalline (LC) Polymers 5

1.1.5 The ER Phenomena of LC Polymers 8

1.2 Applications 10

1.3 Objectives 11

II LITERATURE SURVEY 12

2.1 The Particle Dispersion ER Fluids 12

2.2 The Homogeneous ER Fluids 16

III EXPERIMENTAL 19

3.1 Materials 19

3.2 Methodology 19

3.2.1 Synthesis of Poly(*p*-benzamide) (PBA) 19

CHAPTER		PAGE
	3.2.2 Preparation of PBA Solution for LC Formation	20
	3.2.3 Preparation of PBA Dispersion System for ER Fluid	20
	3.3 Characterization	21
	3.3.1 Spectroscopic Characterization	21
	3.3.2 Thermal Analysis	23
	3.3.3 Viscosity Measurement	23
	3.3.4 Formation of Liquid Crystalline (LC) Phase	25
	3.3.5 Characterization for ER Fluids	26
	3.4 ER Measurements	
	3.4.1 Dynamic Strain Sweep Default Test	27
	3.4.2 Dynamic Frequency Sweep Default Test	28
IV	**RESULTS AND DISCUSSION**	29
	4.1 Characterization of Synthesized PBA	29
	4.1.1 Molecular Weight Variation	29
	4.1.2 Spectroscopic Characterization	36
	4.1.3 Thermal Analysis	42
	4.2 The Formation of Liquid Crystalline Phase of PBA Solution	44
	4.2.1 The Effect of Polymer Structure	44
	4.2.2 The Effect of Molecular Weight	59
	4.2.3 The Effect of Polymer-Solvent Interaction	62
	4.3 ER Measurement of PBA-1 Suspension	70
	4.3.1 Effect of Strain Amplitude	71
	4.3.2 Transient Response	75
	4.3.3 Effect of Frequency	76

CHAPTER **PAGE**

IV **CONCLUSIONS** 87

REFERENCES 89

APPENDICES 94

Appendix A 94

Appendix B 96

Appendix C 116

Appendix D 125

Appendix E 129

Appendix F 136

CURRICULUM VITAE 138

LIST OF TABLES

TABLE		PAGE
1.1	Electrorheological properties and corresponding technical applications	3
3.1	Preparation of PBA solution for LC formation	21
3.2	Preparation of PBA dispersion ER fluid	21
4.1	Summary of molecular weight variation of PBA	32
4.2	Molecular weight of PBA in dilute systems	33
4.3	Remarks and assignments of peaks from FTIR spectra for PBA	38
4.4	Remarks and assignments of peaks from the solution state ^{13}C-NMR spectrum for PBA-1	39

LIST OF FIGURES

FIGURE **PAGE**

1.1 (a) In the presence of an electric field, the particles in an electrorheological (ER) fluid form chains or fibrillated structures (b) Mechanism of fibrillation and alignment of dielectric particles. The interaction of these dipoles cause attraction, repulsion, rotation, and alignment of particles, creating chains that align with the applied electric field 4
1.2 Schematic representation of the domain theory 6
1.3 The graph showing the viscosity-concentration relationship of a solution of poly(p-phenylene terephthalamide) (PPTA) with a moderate molecular weight in sulfuric acid 6
1.4 Repeating unit of poly(*p*-benzamide) 8
1.5 Presumed orientation of conventional liquid crystals and LC polymers under applied electric field: (a) low molecular weight liquid crystal; (b) liquid crystalline polymer 9
1.6 Miesowicz viscosities: (a) director perpendicular to flow direction and velocity gradient; (b) director parallel to flow direction; (c) director parallel to velocity gradient $(\eta_a, \eta_b < \eta_c)$ 10

FIGURE **PAGE**

4.1 The relationship between molecular weight (MW), degree of polymerization (X_n), and reaction time (t) of condensation polymerization when X_n is equal to number average molecular weight (M_n) over molecular weight of repeating unit 31

4.2 η_{sp}/C and $(\ln \eta_r)/C$ versus PBA concentration of PBA-1 at 25^0C 34

4.3 η_{sp}/C and $(\ln \eta_r)/C$ versus PBA concentration of PBA-9 at 25^0C 34

4.4 η_{sp}/C and $(\ln \eta_r)/C$ versus PBA concentration of PBA-2 at 25^0C 35

4.5 The FTIR spectra of PBA: (a) PBA-1, (b) PBA-2, and (c) PBA-9 36

4.6 The UV-VIS spectra of PBA in 96% H_2SO_4: (a) PBA-1 (10 ppm), (b) PBA-2 (15 ppm), and (c) PBA-9 (18 ppm) 37

4.7 The UV-VIS spectra of PBA in 3%LiCl/DMAc: (a) PBA-1 (16 ppm), (b) PBA-2 (10 ppm), and (c) PBA-9 (18 ppm) 37

4.8 The ^{13}C-NMR spectrum of PBA-1 in 98% D_2SO_4 39

4.9 The solid state ^{13}C CP/MAS NMR spectrum of PBA-1 40

4.10 The solid state ^{13}C CP/MAS NMR spectrum of PBA-2 40

4.11 The solid state ^{13}C CP/MAS NMR spectrum of PBA-9 41

4.12 The DSC thermograms of PBA 42

4.13 The TGA thermograms of PBA 43

4.14 The zero-shear rate viscosity of PBA-2 in 4%LiCl/DMAc at 25^0C 47

FIGURE **PAGE**

4.15 The zero-shear rate viscosity of PBA-2 in 4%LiCl/NMP at 25^{0}C 47

4.16 The zero-shear rate viscosity of PBA-1 in 4%LiCl/DMAc at 25^{0}C 48

4.17 The zero-shear rate viscosity of PBA-1 in 4%LiCl/NMP at 25^{0}C 48

4.18 Structure of (a) nematic , (b) cholesteric , and (c) smectic C phase 50

4.19 A polarized light micrograph of a sectioned nematic thermotropic LC polymer reveals a schlieren texture 50

4.20 Polarized optical micrographs of PBA-2 in 4%LiCl/DMAc at 25^{0}C with different concentrations:
(a) Isotropic phase, C = 1.01-4.00 wt%;
(b) Biphasic phase, C = 4.26-5.15 wt%;
(c) Biphasic phase, C = 5.55 wt%; and
(d) Fully LC phase, C = 6.10-8.10 wt% 53

4.21 Polarized optical micrographs of PBA-2 in 4%LiCl/NMP at 25^{0}C with different concentrations:
(a) Isotropic phase, C = 1.01-4.02 wt%;
(b) Biphasic phase, C = 4.25-5.12 wt%;
(c) Biphasic phase, C = 5.34 wt%; and
(d) Fully LC phase, C = 5.61-8.06 wt% 56

FIGURE PAGE

4.22 Polarized optical micrographs of PBA-1 in 4%LiCl/DMAc at 25^{0}C with different concentrations: 59
(a) Isotropic phase, C = 4.01-8.05 wt%;
(b) Biphasic phase, C = 9.99-13.04 wt%;
(c) Biphasic phase, C = 13.50 wt%; and
(d) Fully LC phase, C = 14.16 and 15.06 wt%
4.23 Polarized optical micrographs of PBA-1 in 4%LiCl/NMP at 25^{0}C with different concentrations: 62
(a) Isotropic phase, C = 4.00-8.08 wt%;
(b) Biphasic phase, C = 10.13-12.89 wt%;
(c) Biphasic phase, C = 13.20 wt%; and
(d) Fully LC phase, C = 13.51-14.15 wt%
4.24 The zero-shear rate viscosity of PBA-1 and PBA-2 in 4%LiCl/DMAc at 25^{0}C 64
4.25 The zero-shear rate viscosity of PBA-1 and PBA-2 in 4%LiCl/NMP at 25^{0}C 64
4.26 Postulated structure of solvated PBA in (a) LiCl/DMAc and (b) LiCl/NMP solvents 63
4.27 The rero-shear rate viscosityof PBA-1 in 4%LiCl/DMAc and 4%LiCl/NMP solvents at 25^{0}C 65
4.28 The rero-shear rate viscosityof PBA-2 in 4%LiCl/DMAc and 4%LiCl/NMP solvents at 25^{0}C 65
4.29 Typical flow curve of LC polymer 66
4.30 Some flow curves of PBA-2 in 4%LiCl/DMAc 67
4.31 Some flow curves of PBA-2 in 4%LiCl/NMP 67
4.32 Some flow curves of PBA-1 in 4%LiCl/DMAc 68
4.33 Some flow curves of PBA-1 in 4%LiCl/NMP 68

FIGURE **PAGE**

4.34 G' and G'' dependence on %strain of 10 wt% PBA-1 suspension at the electric field strength of 2 kV/mm 71

4.35 G' and G'' dependence on %strain of 10 wt% PBA-1 suspension at the electric field strength of 1 kV/mm 72

4.36 G' and G'' dependence on %strain of 10 wt% PBA-1 suspension at the electric field strength of 0.5 kV/mm 72

4.37 G' and G'' dependence on %strain of 10 wt% PBA-1 suspension at the electric field strength of 0.4 kV/mm 73

4.38 G' and G'' dependence on %strain of 10 wt% PBA-1 suspension at the electric field strength of 0.25 kV/mm 73

4.39 G' and G'' dependence on %strain of 10 wt% PBA-1 suspension at the electric field strength of 0.02 kV/mm 74

4.40 G' and G'' dependence on %strain of 10 wt% PBA-1 suspension at the electric field strength of 0 kV/mm 74

4.41 G' and G'' dependence of the 10 wt% PBA-1 suspension at the electric step field strength of 2 kV/mm and frequency of 1 rad/s 76

4.42 G' dependence on frequency of 10 wt% PBA-1 suspension at various electric field strengths in the linear viscoelastic regime 78

4.43 G'' dependence on frequency of 10 wt% PBA-1 suspension at various electric field strengths in the linear viscoelastic regime 79

4.44 G' and G'' dependence on frequency of 10 wt% PBA-1 suspension in the linear viscoelastic regime at electric field strengths of 0.4 kV/mm 80

FIGURE **PAGE**

4.45 G' and G'' dependence on frequency of 10 wt% PBA-1 suspension in the linear viscoelastic regime at electric field strengths of 0.5 kV/mm 80

4.46 G' and G'' dependence on frequency of 10 wt% PBA-1 suspension in the linear viscoelastic regime at electric field strengths of 1 kV/mm 81

4.47 G' and G'' dependence on frequency of 10 wt% PBA-1 suspension in the linear viscoelastic regime at electric field strengths of 2 kV/mm 81

4.48 Tan δ dependence on frequency of 10 wt% PBA-1 suspension at various electric field strengths in the linear viscoelastic regime 82

4.49 $[G']_0$ and $[G'']_0$ at various electric field strengths in the linear viscoelastic regime 83

4.50 G'' dependence on frequency of 10 wt% PBA-1 suspension at various electric field strengths in the nonlinear viscoelastic regime 85

4.51 $[G'']_0$ at various electric field strengths in the nonlinear viscoelastic regime 86