# DYNAMICS OF VORTICITY STRETCHING AND BREAKUP OF ISOLATED VISCOELASTIC DROPLETS IN AN IMMISCIBLE VISCOELASTIC MATRIX

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# ABSTRACT

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Elastic polystyrene (PS) droplets dispersed in an elastic high density polyethylene (HDPE) matrix are observed under a simple shearing flow between two transparent parallel disks. Two grades of HDPE and of PS, are used to formulate two immiscible blends with the same viscosity ratio of unity but different elasticities and elasticity ratios. Rather than deform in the flow direction and break up at a capillary number of near unity, as is the case for Newtonian droplets in a Newtonian medium, the viscoelastic droplets initially deform in the flow direction after startup of steady shear, but then begin reverting to a spherical shape, and, for the more elastic blend, eventually deform in the vorticity direction. With increasing capillary number, the droplet deforms increasingly along the vorticity direction, and above a critical capillary number $Ca_c$, breakup occurs when two ends of a drop situated on widely separated streamlines with significantly different velocities are displaced from each other under flow. The transition from alignment in the flow direction for Newtonian or slightly elastic droplets to alignment in the vorticity direction for highly elastic droplets can lead to very large increases of the critical capillary number for droplet breakup. In addition, the deformation parameter in the relaxation process of both systems, decays exponentially with time after cessation of steady-state shear, until long times are reached. The characteristic relaxation time is larger when the capillary number increases.

# บทคัดย่อ

ทิพยา เชิดหิรัญกร: พลศาสตร์ของการยืดตามแนวแกนหมุนของอนุภาคพอลิเมอร์ที่มีความยืดหยุ่นและความหนืดผสมในพอลิเมอร์ที่ไม่เข้ากัน (Dynamics of Vorticity Stretching and Breakup of Isolated Viscoelastic Droplets in an Immiscible Viscoelastic Matrix) อ.ที่ปรึกษา: รศ.ดร. อนุวัฒน์ ศิริวัฒน์ และ ศ.ดร.โรนัลด์ จี ลาร์ซัน 98 หน้า ISBN 974-17-2345-8

สมบัติของพอลิเมอร์ผสมขึ้นกับตัวแปรต่าง ๆ เช่น สมบัติทางกายภาพของพอลิเมอร์บริสุทธิ์ ค่าแรงเฉือน ค่าแรงตึงผิวระหว่างพอลิเมอร์ผสม เป็นต้น รายงานวิจัยนี้ กล่าวถึงผลของการศึกษาพฤติกรรมต่าง ๆ ของอนุภาคทรงกลมของพอลิเมอร์เหลว ที่กระจายตัวอย่างเบาบางมากในพอลิเมอร์ส่วนต่อเนื่องที่มีความยืดหยุ่นสูง ซึ่งทดลองภายใต้อุปกรณ์กำเนิดแรงเฉือนชนิดโปร่งใส พอลิเมอร์ที่ใช้เป็นส่วนต่อเนื่องคือ พอลิเอทิลีนความหนาแน่นสูง 2 ชนิด ที่มีความหนืดและความยืดหยุ่นแตกต่างกันมาก และพอลิเมอร์ที่ใช้เป็นส่วนกระจายตัวคือ พอลิสไตรีน 2 ชนิด ที่มีความหนืดและความยืดหยุ่นแตกต่างกันมาก เช่นกัน พอลิเมอร์ผสมที่ทำการศึกษามีสองระบบ ที่มีสัดส่วนความหนืดเท่ากับ 1 แต่แตกต่างกันที่สัดส่วนความยืดหยุ่นที่แรงเฉือนเดียวกัน จากการศึกษาพบว่า ภายใต้แรงเฉือนคงที่ อนุภาคทรงกลมของพอลิเมอร์ส่วนกระจายตัวจะเริ่มยืดออกในแนวเดียวกับแรงเฉือน และค่อยๆหดตัวในแนวแรงเฉือนพร้อมกับยืดออกในแนวตั้งฉากกับแรงเฉือน หรือเรียกอีกอย่างหนึ่งว่า แนวแกนหมุน สำหรับพอลิเมอร์ผสมทั้งสองระบบ เมื่อค่าคาปิลารี่เพิ่มขึ้น การยืดในแนวแกนหมุนจะเพิ่มขึ้น จนกระทั่งปลายทั้งสองของอนุภาคพอลิเมอร์อยู่ห่างกันมากและอยู่ในระดับที่มีความแตกต่างของความเร็วของของไหลมากขึ้นเรื่อยๆ จนทำให้หยดพอลิเมอร์ส่วนกระจายตัวฉีกขาดในที่สุด

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## TABLE OF CONTENTS


| | | PAGE |
|---|---|---|
| Title Page | | i |
| Abstract (in English) | | iii |
| Abstract (inThai) | | iv |
| Acknowledgements | | v |
| Table of Contents | | vi |
| List of Tables | | viii |
| List of Figures | | ix |
| **CHAPTER** | | |
| **I** | **INTRODUCTION** | 1 |
| **II** | **LITERATURE REVIEW** | 4 |
| **III** | **EXPERIMENTAL** | 8 |
| | 3.1 Materials | 8 |
| | 3.2 Rheological Characterization | 9 |
| | 3.3 Observation of an Isolated Droplet in Shearing Flow | 12 |
| | 3.3.1 Shearing Apparatus | 12 |
| | 3.3.2 Sample Preparation | 12 |
| | 3.3.3 Determination of Interfacial Tension | 12 |
| | 3.3.4 Transient Deformation | 16 |
| | 3.3.5 Steady-State Deformation and Breakup | 17 |
| **IV** | **DYNAMICS OF VORTICITY STRETCHING AND BREAKUP OF ISOLATED VISCOELASTIC DROPLETS IN AN IMMISCIBLE VISCOELASTIC MATRIX** | 19 |
| | Abstract | 19 |
| | Introduction | 20 |

CHAPTER PAGE

Experiments 26
Results and Discussions 32
Conclusions 37
Acknowledgements 37
References 38

V **CONCLUSIONS AND RECOMMENDATIONS** 60

**REFERENCES** 61

**APPENDICES**
**Appendix A** Rheological characterization 64
**Appendix B** Stabilities testing 71
**Appendix C** Determination of interfacial tension 72
**Appendix D** Raw data in transient experiments 76
**Appendix E** Raw data in steady state experiments 92
**Appendix F** Relaxation after cessation of steady shear 94

**CURRICULUM VITAE** 98

# LIST OF TABLES


| TABLE | | PAGE |
|---|---|---|
| | **CHAPTER III** | |
| 3.1 | Properties of polymer blend components | 8 |
| 3.2 | Polymer blend systems | 8 |
| | **CHAPTER IV** | |
| 1 | Properties of polymer blend components. | 40 |
| 2 | Polymer blend systems. | 40 |
| | **APPENDICES** | |
| A1 | Viscosity, $N_1$, and G' vs shear rate and oscillation frequency of HDPE1 at 147°C | 65 |
| A2 | Viscosity, $N_1$, and G' vs shear rate and oscillation frequency of PS1 at 147°C | 67 |
| A3 | Viscosity vs shear rate and storage modulus vs oscillation frequency of HDPE2 at 139°C | 69 |
| A4 | Viscosity vs shear rate and storage modulus vs oscillation frequency of PS2 at 139°C | 70 |
| C1 | Interfacial tension of system A (PS1/HDPE1 at 147°C) | 74 |
| C2 | Interfacial tension of system B (PS2/HDPE2 at 139°C) | 75 |
| D1 | Raw data of transient experiment System A at 147°C; $\dot{\gamma}$ = 0. 5 $s^{-1}$, $D_o \approx 75 \pm 7$ μm) | 76 |
| D2 | Raw data of transient experiment System A at 147°C; $\dot{\gamma}$ = 0. 5 $s^{-1}$, $D_o \approx$ 52, 110, and 122 μm) | 81 |
| D3 | Raw data of transient experiment System A at 147°C; $\dot{\gamma}$ = 0. 28 $s^{-1}$, $D_o \approx$ 135 μm) | 86 |
| D4 | Raw data of transient experiment System A at 147°C; $\dot{\gamma}$ = 0. 8 $s^{-1}$, $D_o \approx$ 46 μm) | 90 |
| E1 | Raw data of steady state experiment; system A at 147°C | 92 |
| E2 | Raw data of steady state experiment; system B at 139°C | 93 |

# LIST OF FIGURES


| FIGURE | | PAGE |
|---|---|---|
| | **CHAPTER I** | |
| 1.1 | Schematic representation of drop deformation in shear flow | 2 |
| | **CHAPTER III** | |
| 3.1 | Viscosity $\eta$, storage modulus G', and first normal stress difference $N_1$ as functions of shear rate and frequency for each pure polymer at the temperatures at which the blend experiments were carried out; (a) matrix phase [HDPE1 at 147°C: $\eta$ (●), G' (o), and $N_1$ (⊙), HDPE2 at 139°C: $\eta$ (■) and G'(□)] and (b) droplet phase [PS1 at 147°C: $\eta$ (▲), G' (△), and $N_1$ (⏃), PS2 at 139°C: $\eta$ (◆) and G'(◇)]. | 10 |
| 3.2 | The ratios of droplet to matrix values of the viscosity $\eta$ (●), storage modulus G' (o), and first normal stress difference $N_1$ (▲) for (a) system A: PS1/HDPE1 at 147°C and (b) system B: PS2/HDPE2 at 139°C. These two temperatures apply to all results in the following figures for systems A and B, respectively. | 11 |
| 3.3 | Dependence of apparent interfacial tension value on droplet size for (a) system A and (b) system B, inferred from the Palierne formula, Eq. 3.2. | 14 |
| 3.4 | Schematic drawing of a single drop observed from the "side" and "top" view by optical microscopy, a and b: the long and short axes of the droplet in the flow-gradient plane, a*: the a axis projected into the flow direction and c: the principal axis in the radial direction. | 16 |

**FIGURE** **PAGE**

**CHAPTER IV**


1 Viscosity η, storage modulus G', and first normal stress difference $N_1$ as functions of shear rate and frequency for each pure polymer at the temperatures at which the blend experiments were carried out; (a) matrix phase [HDPE1 at 147°C: η (●), G' (o), and $N_1$ (◎), HDPE2 at 139°C: η (■) and G'(□)] and (b) droplet phase [PS1 at 147°C: η (▲), G' (△), and $N_1$ (◬), PS2 at 139°C: η (◆) and G'(◇)]. 44

2 The ratios of droplet to matrix values of the viscosity η (●), storage modulus G' (o), and first normal stress difference $N_1$ (▲) for (a) system A: PS1/HDPE1 at 147°C and (b) system B: PS2/HDPE2 at 139°C. These two temperatures apply to all results in the following figures for systems A and B, respectively. 46

3 Dependence of apparent interfacial tension value on droplet size for (a) system A and (b) system B, inferred from the Palierne formula, Eq. 4. 47

4 Schematic drawing of a single drop observed from the "side" and "top" view by optical microscopy, a and b: the long and short axes of the droplet in the flow-gradient plane, a*: the a axis projected into the flow direction and c: the principal axis in the radial direction. 48

| FIGURE | | PAGE |
|---|---|---|
| 5 | The time-dependent deformation of 75 (±10%)μm-drops after startup of steady shear at a rate, 0.5 $s^{-1}$, for system A. (a) Def* vs. time on a log time scale, (b) Def* vs. time on a linear time scale, (c) $a^*/D_o$ vs. time on a log time scale, and (d) $c/D_o$ vs. time on a log time scale. [initial droplet sizes (μm): 76 (●), 68 (⊙), 74 (▼), 69 (▽), 71 (■), 85 (⊡), 76 (◆), 75 (◈), 74 (▲), 70 (◬), and 79 (⬢)] | 49 |
| 6 | Sequence of images of deformed droplets of initial radius 75 (±10%) μm- after startup of a steady shear at a rate of 0.5 $s^{-1}$ for system A; (a)-(f) images of different droplets with lens magnification of 20x [$D_o$ = 69, 69, 71, 76, 75, and 74 μm, respectively]; (g)-(p) images of a single droplet with the lens magnification of 4x [$D_o$ = 79 μm]. | 51 |
| 7 | Schematic drawing of droplet rotation in the flow-gradient plane. | 52 |
| 8 | Sketch of a steady-state deformed droplet. | 52 |
| 9 | Time-dependent deformation of a 204 μm-droplet under constant shear rate, 0.4 $s^{-1}$, for system B. | 53 |
| 10 | Time-dependent droplet deformation at different values of Ca, controlled by changing the droplet diameter $D_o$ [$D_o$ = 52 μm; Ca = 5 (●), $D_o$ = 79 μm; Ca = 8 (o), $D_o$ = 110 μm; Ca = 11 (▼), $D_o$ = 120 μm; Ca = 12 (▽)] at the same shear rate 0.5 $s^{-1}$ (and therefore the same elasticity) for system A: (a) Def*, (b) $a^*/D_o$, and (c) $c/D_o$. | 54 |

**FIGURE** **PAGE**


11 Time-dependent droplet deformation at different shear rates (and therefore different elasticities), at a capillary number Ca of 8, held fixed by varying by varying the initial droplet diameter inversely with the shear rate for system A: (a) Def* vs time, (b) $a^*/D_o$ vs time, and (c) $c/D_o$ vs time. Three different shear rates were used. (1): $\dot{\gamma}$ = 0.28 $s^{-1}$, with $D_o$ = 135 μm (▲) and a repeat run at this shear rate with the same droplet size, $D_o$ = 135 μm (△)]. (2): $\dot{\gamma}$ = 0.5 $s^{-1}$: $D_o$ = 70 μm (●), and a repeat run with a slightly larger droplet, $D_o$ = 79 μm (o). (3) $\dot{\gamma}$ = 0.8 $s^{-1}$, $D_o$ = 45 μm (■)]. 56

12 Dependence of steady-state deformation parameter on Ca for system A: shear rate 0.3 $s^{-1}$ (○), shear rate 0.5 $s^{-1}$ (▲), and for system B: shear rate 1 $s^{-1}$ (▣)]. 58

13 Sequence of images during droplet breakup in system A, $D_o$= 120 μm, at a shear rate of 0.5 $s^{-1}$ (Ca=12). The flow direction is horizontal, and the vorticity direction vertical. 59


## APPENDICES


B1 Stability of polymer viscosities at the constant shear rate of 0.5 $s^{-1}$ 71

C1 Semi-log plot of the relaxation shape vs. time after application of small shear strain, 2%, for system A (Shear rate of 0.2 $s^{-1}$ and the initial droplet size of 192 μm) 73

C2 Dependence of the applied strain on the interfacial tension, for system A. (Initial droplet size of around 290±40 μm at shear rate of 1 $s^{-1}$) 73

**FIGURE** **PAGE**

F1 Recovery of Def* normalized by its steady-state value $Def^*_{ss}$ after cessation of steady-state shear: for system A:,(a) Shear rate 0.3 $s^{-1}$, (b) Shear rate 0.5 $s^{-1}$; and for system B, (c) Shear rate 1 $s^{-1}$. 95

F2 Dependence of the characteristic relaxation time on shear rate: for system A, shear rate 0.3 $s^{-1}$ (●), shear rate 0.5 $s^{-1}$ (o); and for system B, shear rate 1 $s^{-1}$ (▲). 97