DROP BREAKUP AND RHEOLOGICAL PROPERTIES OF POLYSTYRENE/POLYPROPYLENE BLENDS

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A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science
The Petroleum and Petrochemical College, Chulalongkorn University
in Academic Partnership with
The University of Michigan, The University of Oklahoma,
and Case Western Reserve University
2000

ISBN 974-334-167-6

I19313276

Thesis Title	:	Drop Breakup and Rheological Properties of Polystyrene/Polypropylene Blends
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131677

ABSTRACT

4172005063 : POLYMER SCIENCE PROGRAM
KEYWORD : Drop breakup/ Coalescence/ Capillary number/ viscosity ratio/ The first normal stress difference ratio
Chatriya Suamsung: Drop Breakup, Coalescence and Rheological Properties of Polystyrene/Polypropylene Blends. Thesis Advisors: Prof. Ronald G. Larson, Assoc. Prof. Anuvat Sirivat, 81 pp. ISBN 974-334-167-6

In order to control the polymer blend rheological properties, a better understanding of mechanisms of drop breakup and coalescence during processing is very important. In this work, the morphology of dispersed phase in terms of number average droplet size was investigated as a function of shearing time and shear strain rate. The number average droplet sizes were found to reach the statistical equilibrium morphology with monomodal size distributions at the shear strain unit about 10,000 for PS/PP blends at high and low viscosity ratios. Only drop breakup process was observed in our investigation. For the effect of elasticity, the correlation between two dimensionless parameters, capillary number (Ca) and the first normal stress difference ratio ($N_{1,r}$) was observed. Ca was found to increase linearly with the first normal stress difference ratio at any given value of viscosity ratio. For a given the first normal stress difference ratio, Ca was found to be surprisingly higher for a lower viscosity ratio. The capillary number of the viscoelastic systems was higher than that of a Newtonian system due to the effect of elasticity in the immiscible polymer blends investigated.

บทคัดย่อ

นางสาวฉัตรีญา สวมสูง : การแตกตัวของอนุภาคทรงกลมและคุณสมบัติการไหลที่เกิดจากการเฉือนของสารผสมพอลิเมอร์ระหว่าง พอลิสไตรีน/พอลิโพรพิลีน (Drop Breakup and Rheological Properties of Polystyrene/Polypropylene Blends) อ. ที่ปรึกษา : ศ. ดร. รอนาล ลาสัน และ รศ. ดร. อนุวัฒน์ ศิริวัฒน์ 81 หน้า ISBN 974-334-167-6

งานวิจัยนี้ศึกษาและค้นคว้าผลของแรงเฉือนและระยะเวลาของการเฉือนต่อโครงสร้างภายในของสารผสมพอลิเมอร์ที่ไม่สามารถรวมตัวเป็นเนื้อเดียวกัน ซึ่งได้แก่ พอลิสไตรีน/พอลิโพพิลีน ขนาดโดยเฉลี่ยจากจำนวนของอนุภาคทรงกลมถูกศึกษาโดยขึ้นอยู่กับเวลาในการเฉือนและอัตราเร็วของการเฉือน จากผลการทดลองพบว่าขนาดโดยเฉลี่ยจากจำนวนของอนุภาคทรงกลมทั้งอัตราส่วนความหนืดสูงและความหนืดต่ำ เข้าสู่สภาวะสมดุลโดยมีการกระจายตัวแบบเอกกาพ เมื่อความเครียดเฉือนมีค่า 10000 ที่สภาวะการทดลองนี้ มีเพียงปรากฏการณ์การแตกตัวของอนุภาคทรงกลมเกิดขึ้นเท่านั้น

สำหรับการศึกษาผลกระทบจากความยืดหยุ่นนั้น ได้ทำการศึกษาจากความสัมพันธ์ระหว่างอัตราส่วนระหว่างแรงเฉือนต่อแรงพยุงตัวของอนุภาคทรงกลม (Capillary Number) กับอัตราส่วนระหว่างความยืดหยุ่นของสารพอลิเมอร์ทั้งสอง พบว่า อัตราส่วนระหว่างแรงเฉือนต่อแรงพยุงตัวของอนุภาคทรงกลม ณ.อัตราส่วนของความหนืดต่างๆ มีค่าเพิ่มขึ้นโดยตรงกับอัตราส่วนระหว่างความยืดหยุ่นของสารสองชนิด โดยอัตราส่วนระหว่างแรงเฉือนต่อแรงพยุงตัวเพิ่มขึ้นเมื่ออัตราส่วนของความหนืดสูงขึ้น นอกจากนี้ผลที่ได้จากการทดลองทั้งหมดมีค่าสูงกว่า ระบบที่ไม่มีความยืดหยุ่น (Newtonian system)

ACKNOWLEDGEMENTS

The author gratefully gives special thanks to her U.S. advisor, Prof. Ronald G. Larson for his recommendations on the research. She is also deeply indepted to her Thai advisors, Assoc. Prof. Anuvat Sirivat, who not only originated the thesis work, but also gave the intensive suggestion, invaluable guidance, constructive advices and vital help throughout this research work.

She greatly appreciates all professors for invaluable knowledge to hers at the Petroleum and Petrochemical College, Chulalongkorn University.

She would like to express her thanks to HMC Polymer Company and Dow Chemical for supporting polypropylenes and polystyrenes.

Finally, the sincerest appreciation is for her family for the love, understanding, encouragement and financial support.

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LIST OF SYMBOLS

SYMBOL

Subscript-d	dispersed phase
Subscript-m	matrix phase
η_d	shear viscosity of dispersed phase (dyn/cm^2.s)
η_m	shear viscosity of matrix phase (dyn/cm^2.s)
η_r	shear viscosity ratio
$N_{1.d}$	the first normal stress difference of dispersed phase (dyn/cm^2)
$N_{1.m}$	the first normal stress difference of matrix phase (dyn/cm^2)
$N_{1.r}$	the first normal stress difference ratio
Ca	Capillary number
D	drop diameter (μm)
D_n	number average diameter of dispersed phase (μm)
Γ	interfacial tension (dyn/cm)
γ	shear strain rate (s^{-1})