

SHEAR FRACTURE OF HIGH DENSITY POLYETHYLENE MELTS

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for the Degree of Master of Science
The Petroleum and Petrochemical College, Chulalongkorn University
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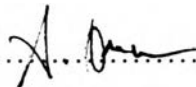
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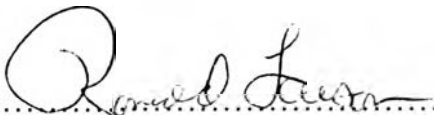
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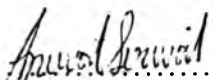
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นางสาวมนตรา ธรรมชาติ : การศึกษาผิวขรุขระบริเวณผิวหน้าของพอลิเอททิลีนความหนาแน่นสูง (Shear Fracture of High Density Polyethylene Melts) อาจารย์ที่ปรึกษา : ศ. ดร. รอนาลด์ ลาร์สัน และ รศ. ดร. อนุวัฒน์ ศิริวัฒน์ 67 หน้า ISBN 974-331-925-5

การศึกษาการไหลของของเหลวผ่านภายในท่อและช่องต่างๆนั้นมีความสำคัญมากในกระบวนการผลิตและขึ้นรูปของพลาสติกที่มีขนาดเล็ก การวิจัยนี้เป็นการศึกษาการลื่นที่ผนังของแข็งของพอลิเอททิลีนความหนาแน่นสูงโดยใช้เครื่องมือวัดสมบัติการไหลแบบโคนและเพลท ความถี่วิกฤตและความเครียดวิกฤตซึ่งคือความถี่และความเครียดที่การลื่นเกิดขึ้นมีแนวโน้มเพิ่มขึ้นเมื่อความเค้นที่ให้เข้าไปแก่ระบบเพิ่มขึ้น การทดลองแบ่งเป็นสองช่วงคือช่วงวิสโคอิลาสติกที่เป็นเส้นตรงและไม่เป็นเส้นตรง สำหรับช่วงวิสโคอิลาสติกที่เป็นเส้นตรงที่อุณหภูมิ 160 และ 180 องศาเซลเซียสพบว่ากลไกการลื่นมีสองแบบร่วมกันคือการหลุดของสายพอลิเมอร์ที่ผิวของแข็งและการเกิดรูที่ผิวพอลิเมอร์ที่สัมผัสกับผิวของแข็ง ส่วนในช่วงวิสโคอิลาสติกที่ไม่เป็นเส้นตรงพบว่ากลไกการลื่นคือการหลุดของสายพอลิเมอร์เพียงอย่างเดียว ที่อุณหภูมิ 200 องศาเซลเซียส ค่าโมดูลัสเชิงซ้อนประพจน์ตัวต่างไปจากที่ 160 และ 180 องศาเซลเซียส นั่นคือ ค่าโมดูลัสเชิงซ้อนมีแนวโน้มทั้งเพิ่มขึ้นและลดลงขึ้นอยู่กับความถี่ที่ให้เข้าไป การเพิ่มขึ้นของโมดูลัสเชิงซ้อนเกิดจากการเชื่อมกันของสายพอลิเมอร์ที่อุณหภูมิสูง ส่วนการลดลงของโมดูลัสเชิงซ้อนเกิดจากการเกิดรูที่ผิวพอลิเมอร์ที่สัมผัสกับผิวของแข็ง

ABSTRACT

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KEY WORDS : Shear Fracture/ Slip/ Desorption/ Disentanglement

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Surface smoothness is one of the critical requirements in plastic processing of small-scale products, which require accurate manufacturing. Therefore skin roughness poses a challenging problem for micron-size manufacturing. The rheological properties of HDPE were measured using cone-and-plate rheometer in dynamic mode in order to study the slippage on a solid surface. Critical frequencies and critical stresses, which are the frequencies and stresses that slippage occur, increase with the strain imposed. Our data can be divided into linear viscoelastic regime (LVR) and nonlinear viscoelastic regime (NVR). The mechanisms of slip in both regimes are different depending on temperature. For the NVR at the temperatures of 160 and 180°C, decay in G^* was caused by desorption between polymer chains and solid wall, while in the LVR desorption and voids formation were observed. Different results were obtained at 200°C, in which G^* rose and decayed. Rising in G^* was caused by cross-linking while the decay in G^* was caused by voids formation.

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LIST OF SYMBOLS

SYMBOL

G'	Storage modulus (dyn/cm ²)
G''	Loss modulus (dyn/cm ²)
G^*	Complex modulus (dyn/cm ²)
η	Viscosity (Poise)
η'	Storage viscosity (Poise)
η''	Loss viscosity (Poise)
η_0	Zero shear viscosity (Poise)
M	Molecular weigh (g/mole)
ρ	Density (g/cm ³)
T	Temperature (K)
ω	Angular frequency (rad/s)
f	Oscillating frequency (1/s)
λ	Relaxation time (s)
σ	Stress (dyn/cm ²)
γ	Strain (%)
N	Normal force different (dyn/cm ²)
θ	Angular displacement (rad)
β	Cone angle (rad)
$\Delta\theta$	Transient angular slip (rad)
b	Slip/ Extrapolation length (cm)
V_s	Slip velocity (cm/s)