POLYLACTIDE COMPOUNDING FOR INJECTION MOLDING PRODUCT

Sirinya Pairote

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By: Sirinya Pairote

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Thesis Advisor: Assoc. Prof. Rathanawan Magaraphan

Accepted by the Petroleum and Petrochemical College, Chulalongkorn University, in partial fulfillment of the requirements for the Degree of Master of Science.

..... College Director

(Asst.Prof. Pomthong Malakul)

Thesis Committee

.....

(Assoc. Prof. Rathanawan Magaraphan)

.....

(Asst. Prof. Manit Nithitanakul)

.....

(Assoc.Prof. Kalyanee Sirisinha)

561014

ABSTRACT

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The ring-opening polymerization of lactide was synthesized in single step process via using stannous (II) octoate, $Sn(Oct)_2$ as a catalyst to get the high molecular weight of polylactide (PLA). For improving the thermal and mechanical properties of PLA, the graft copolymerization between a lactide monomer and epoxidized natural rubber (ENR), ENR-g-PLA was synthesized. The ENR-g-PLA copolymers were successfully synthesized and confirmed by FT-IR spectra. The occurrence peak at 1740 cm^{-1} and 3400 cm^{-1} corresponded to the carbonyl group (C=O) and hydroxyl group (-OH) which resulted from the reaction between PLA and ENR. Moreover, the ENR-g-PLA copolymers gave the molecular weight around 1.87 $\times$ 10^4 to 2.78 $\times$ 10^4 g/mol. The highest amount of copolymer and the highest molecular demonstrated at the catalyst content around 0.2 wt% and the temperature of mixing around 160 °C. Furthermore, the calculation of grafting showed that there was 24%grafting of ENR on PLA. Also, the degree of grafting was directly proportional to various ENR contents. For the thermal properties, the decomposition temperature of copolymer (~355 °C) was higher than pure PLA (~332 °C). In addition, the impact strength of copolymer increased in the presence of ENR. The impact strength of ENR-g-PLA increased 1.5-folds in comparison to pure PLA. The elongation of copolymer was improved compared to pure PLA. Moreover, the morphology of copolymer was studied by FE-SEM. The results revealed the well dispersion phase of ENR in PLA matrix.

บทคัดย่อ

ศิริญญา ไพโรจน์ : ผลิตภัณฑ์ที่ขึ้นรูปโดยกระบวนการฉีด จากสารประกอบโพลีแลคไทด์ สังเคราะห์ (Polylactide Compounding for Injection Molding Product) อ. ที่ปรึกษา : รศ. ดร. รัตนวรรณ มกรพันธุ์ 94 หน้า

ปฏิกิริยาพอลิเมอร์ไรเซชั่นแบบเปิดวงของแลคไทด์ ถูกสังเคราะห์ได้ภายในขั้นตอนเดียว โดยใช้กรดเกลือของธาตุสแตนนัสเป็นตัวเร่งปฏิกิริยาเพื่อให้ได้โพลีแลคไทด์ที่มีน้ำหนักโมเลกุลสูง แต่ยังมีข้อเสียในเรื่องความเปราะและแตกหักง่าย ดังนั้นเพื่อการปรับปรุงคุณสมบัติทั้งทางด้านความร้อนและเชิงกลของโพลีแลคไทด์ สามารถทำได้โดยกระบวนการพอลิเมอร์ไรเซชั่นแบบกราฟระหว่างแลคไทด์โมโนเมอร์และยางธรรมชาติอีพอกซิไดซ์ ซึ่งจะสังเคราะห์ได้เป็น ENR-g-PLA ในส่วนของโครงสร้างทางเคมีของโคพอลิเมอร์นั้นสามารถวิเคราะห์ได้โดยเครื่องวิเคราะห์สารด้วยอินฟราเรด(FTIR) พบว่าจะมีการปรากฏของช่วงคลื่นที่ 1740 cm^{-1} และ 3400 cm^{-1} แสดงถึงหมู่คาร์บอนิลและไฮดรอกซิลที่เป็นผลมาจากปฏิกิริยาระหว่างโพลีแลคไทด์และยางธรรมชาติอีพอกซิไดซ์ นอกจากนี้ ENR-g-PLA โคพอลิเมอร์ยังให้น้ำหนักโมเลกุลประมาณ 1.87 × 104 ถึง 2.78×10^4 กรัม/โมล โดยที่น้ำหนักโมเลกุลสูงสุดของโคพอลิเมอร์นั้นเกิดขึ้นเมื่อความเข้มข้นของตัวเร่งปฏิกิริยาประมาณ 0.2 เปอร์เซ็นต์โดยน้ำหนักและอุณหภูมิของการผสมประมาณ 160 องศา นอกจากนี้ เมื่อคำนวณหาปริมาณการเกิดโคพอลิเมอร์พบว่ามีปริมาณการเกิดโคพอลิเมอร์ของ ENR 24% และประมาณการเกิดโคพอลิเมอร์แปรผันโดยตรงกับปริมาณENR สำหรับสมบัติทางด้านความร้อนนั้นอุณหภูมิในการสลายตัวของโคพอลิเมอร์สูงกว่าโพลีแลคไทด์ อีกทั้งสมบัติเชิงกลในการทนต่อแรงกระแทกนั้นก็เพิ่มขึ้นจากการที่มียางธรรมชาติอีพอกซิไดซ์ เป็นส่วนประกอบโดยการทนต่อแรงกระแทกของ ENR-g-PLA นั้นเพิ่มขึ้น 1.5 เท่าเมื่อเทียบกับโพลีแลคไทด์บริสุทธิ์ สมบัติการยืดตัวของโคพอลิเมอร์สามารถวัดได้โดย เครื่องทดสอบแรงดึง ซึ่งแสดงให้เห็นว่ามีการยืดตัวที่ดีขึ้นเมื่อเทียบกับโพลีแลคไทด์บริสุทธิ์ นอกจากนี้รูปร่างของโคพอลิเมอร์ สามารถศึกษาได้โดยเครื่องฟิลด์อีมิสชันสแกนนิ่งอิเล็กตรอนไมโครสโคป. ซึ่งผลแสดงให้เห็นว่ามีการกระจายตัวที่ดีของวัฏภาคยางธรรมชาติอีพอกซิไดซ์ในโพลีแลคไทด์.

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ABBREVIATIONS

ENR	:	Epoxidized Natural Rubber
ENR-g-PLA	:	Epoxidized Natural Rubber graft polylactide copolymer
LA	:	Lactide monomer
PLA	:	Polylactide