

Catalytic Extrusion of Polylactide/Ethylene Vinyl Alcohol Bioplastic Film



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ABSTRACT

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The ring-opening polymerization of lactide was generated by a continuous single-step reactive extrusion process in the presence of 2-ethylhexanoic acid tin(II) salt, Sn(Oct)₂, as a catalyst to obtain high molecular weight polylactide (PLA). For good practical applications of PLA, the softness of the PLA was modified via the graft copolymerization from poly(ethylene-co-vinyl alcohol) EVOH, which is a biocompatible, flexible and soft random copolymer. To investigate the chemical structure of the graft copolymer, the products were characterized by FTIR. The results show that the strong absorption emerged at 1740 cm⁻¹ in the spectra of EVOH-g-PLA and pure PLA was identical, which assigned to carbonyl (C=O) in PLA. Therefore, these results could be confirmed that the ring-opening polymerization of lactide with EVOH by using catalytic extrusion was carried out successfully. Furthermore, the EVOH-g-PLA copolymers gave the number average molecular weight (M_w) ranging from 24.5x10⁴ to 36.6x10⁴ g/mol. The amount of graft copolymer and the grafting degree showed a maximum at catalyst content around 0.5 wt%. The optimized LA/EVOH content and the screw speed were 50/50 wt% and 40 rpm, respectively. Furthermore, the EVOH-g-PLA copolymers were fabricated into bioplastic films by compression moulding technique for morphological study by SEM and mechanical testing. The elongation of grafted PLA were improved significantly compared to pure PLA. The tradeoff included the reduction of tensile strength.

บทคัดย่อ

พัชรกมน หนูเอียด : ฟิล์มธรรมชาติ โพลีแลคไทด์/เอทิลีนไวนิลแอลกอฮอล์ สังเคราะห์โดยเทคนิคแคทาไลติก เอกทรวงุ่น (Catalytic Extrusion of Polylactide/Ethylene Vinyl Alcohol Bioplastic Film) อ. ที่ปรึกษา : รศ. ดร. รัตนาวรรณ มกรพันธุ์ 107 หน้า

ปฏิกิริยาพอลิเมอไรเซชันแบบเปิดวงของแลคไทด์เกิดขึ้น โดยใช้เทคนิครีแอกทีฟเอกทรวงุ่นซึ่งสามารถทำปฏิกิริยาในขั้นตอนเดียว โดยใช้กรดเกลือของธาตุสแตนนัสเป็นตัวเร่งปฏิกิริยาเพื่อทำการสังเคราะห์โพลีแลคไทด์ที่มีน้ำหนักโมเลกุลสูง แต่เนื่องด้วยความเปราะของโพลีแลคไทด์ซึ่งเป็นข้อจำกัดในการใช้งานหลายประเภท โพลีแลคไทด์จึงจำเป็นต้องมีการปรับปรุงสมบัติทางด้านความอ่อนนุ่มด้วยวิธีการพอลิเมอไรเซชันแบบกราฟ โดยเลือกใช้เอทิลีนไวนิลแอลกอฮอล์ โคพอลิเมอร์ เป็นสายโซ่หลัก เนื่องจากเอทิลีนไวนิลแอลกอฮอล์ โคพอลิเมอร์ มีสมบัติทางด้านความยืดหยุ่นและเข้ากับวัสดุธรรมชาติด้วยกันได้ดี เพื่อศึกษาโครงสร้างทางเคมีของกราฟโคพอลิเมอร์ที่ได้ เครื่องฟูเรียร์ทรานสฟอร์มสเปกโทรสโกปีถูกใช้ในการวิเคราะห์ พบว่าการปรากฏของพีคที่ 1740 cm^{-1} แสดงถึงหมู่คาร์บอนิลในโพลีแลคไทด์ซึ่งเป็นสายโซ่กิ่งในกราฟโคพอลิเมอร์ ซึ่งสามารถยืนยันได้ว่าปฏิกิริยาพอลิเมอไรเซชันแบบเปิดวงของแลคไทด์โดยใช้หมู่ไฮดรอกซิลในเอทิลีนไวนิลแอลกอฮอล์ โคพอลิเมอร์เป็นส่วนที่ทำให้เกิดปฏิกิริยาสามารถประสบความสำเร็จได้ด้วยเทคนิคแคทาไลติกเอกทรวงุ่น ซึ่งกราฟโคพอลิเมอร์ที่สังเคราะห์ได้มีน้ำหนักโมเลกุลเฉลี่ยโดยน้ำหนักประมาณ 24.5×10^4 ถึง 36.6×10^4 กรัม/โมล นอกจากนี้ ยังมีการศึกษาถึงผลกระทบของอัตราส่วนระหว่างแลคไทด์และเอทิลีนไวนิลแอลกอฮอล์ โคพอลิเมอร์ ความเร็วรอบหมุนของสกรู และความเข้มข้นของตัวเร่งปฏิกิริยา พบว่าปริมาณของกราฟโคพอลิเมอร์และประสิทธิภาพในการกราฟให้ค่าสูงสุด เมื่อใช้อัตราส่วนของแลคไทด์ต่อเอทิลีนไวนิลแอลกอฮอล์ประมาณ 50/50 เปอร์เซนต์น้ำหนัก ความเร็วรอบหมุนเท่ากับ 40 รอบต่อนาที และความเข้มข้นของตัวเร่งปฏิกิริยาประมาณ 0.1 เปอร์เซนต์น้ำหนัก และคุณสมบัติเชิงกลของกราฟโคพอลิเมอร์ได้ทำการศึกษาโดยการทดสอบด้วยเครื่องดึงยืด พบว่าสมบัติการยืดออกเพิ่มขึ้น แลกับ การลดลงของความแข็งแรง

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ABBREVIATIONS

LA	Lactide
PLA	Poly lactide
EVOH	Ethylene vinyl alcohol copolymer
EVOH-g-PLA	Ethylene vinyl alcohol copolymer graft polylactide