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COORDINATION INSERTION OF L-LACTIC ACID

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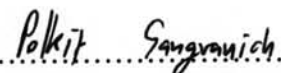
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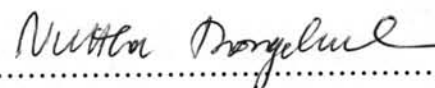
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พอลิแลค-แลกไทด์เป็นพอลิเมอร์ที่สามารถย่อยสลายด้วยกระบวนการทางชีวภาพ อีกทั้งสามารถนำไปใช้ประโยชน์ในหลายด้าน เช่น ทางการแพทย์ อุตสาหกรรมสิ่งทอ และ ภาชนะบรรจุภัณฑ์ เป็นต้น กรดแลค-แลคติกที่ใช้เป็นมอนอเมอร์ในกระบวนการสังเคราะห์ได้จากกระบวนการหมักผลผลิตทางการเกษตรประเภทแป้ง เช่น ข้าวโพด มันสำปะหลัง และมันฝรั่ง เป็นต้น การสังเคราะห์พอลิแลค-แลคติกแอซิดให้มีมวลโมเลกุลสูงจำเป็นต้องทำผ่านกลไกการเปิดวงแลค-แลกไทด์และใช้ตัวเชื่อมโยงสายโซ่พอลิเมอร์ แนวทางแรกเป็นการสังเคราะห์แลค-แลกไทด์จากกรดแลค-แลคติก จากนั้นสังเคราะห์พอลิแลค-แลคติกแอซิดโดยกระบวนการเปิดวงแลค-แลกไทด์โดยแปรเปลี่ยนชนิดตัวริเริ่มปฏิกิริยา $\text{Sn}(\text{Oct})_2$ และ creatine hydrate ตามลำดับ พบว่าสถานะที่เหมาะสมในการสังเคราะห์พอลิเมอร์โดยใช้ $\text{Sn}(\text{Oct})_2$ เป็นตัวริเริ่มปฏิกิริยาควรทำที่อุณหภูมิ 120°C เป็นเวลา 24 ชั่วโมง และ creatine hydrate ควรทำที่ 120°C เป็นเวลา 48 ชั่วโมง ตรวจสอบคุณสมบัติเฉพาะตัวของพอลิแลค-แลคติกแอซิดที่สังเคราะห์ได้ด้วยเทคนิค NMR ตรวจสอบมวลโมเลกุล และอุณหภูมิกลาสทรานสิชันด้วยเทคนิค GPC และ DSC ตามลำดับ พบว่าเมื่อใช้ $\text{Sn}(\text{Oct})_2$ และ creatine hydrate เป็นตัวริเริ่มปฏิกิริยา จะให้พอลิแลค-แลคติกแอซิดที่มีมวลโมเลกุลในช่วง 10,000-30,000 แนวทางที่สองคือการเพิ่มมวลโมเลกุลให้สูงขึ้นโดยใช้ตัวเชื่อมโยงสายโซ่พอลิเมอร์เข้าทำปฏิกิริยา พบว่า tolylene 2,4-diisocyanate terminated poly 1,4-butanediol prepolymer สามารถเพิ่มมวลโมเลกุลได้มากกว่า 1,6-hexamethylene diisocyanate โดยอัตราส่วนที่เหมาะสมระหว่างพอลิแลค-แลคติกแอซิดต่อ tolylene 2,4-diisocyanate terminated poly 1,4-butanediol prepolymer คือ 1:1.1 และสามารถหาอุณหภูมิกลาสทรานสิชันได้ที่อุณหภูมิ 45.1 องศาเซลเซียส

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Poly(L-lactide) (PLLA) is a well-known biodegradable polymer, which has a wide range application in the biomedical, textile, and packaging fields. PLLA is one of the polymers, which can be derived from agricultural resources such as corn, cassava, and potato by mean of fermentation to produce L-lactic acid as monomer. In this work, we attempted to synthesize high molecular weight PLLA via ring-opening polymerization and chain extension. We studied L-lactide synthesis from L-lactic acid. PLLA has been synthesized by L-lactide ring opening. The effects of two initiators (stannous (II) 2-ethylhexanoate and creatine hydrate) were investigated. Suitable conditions for polymerization using stannous (II) 2-ethylhexanoate and creatine hydrate was 120°C at the reaction time 24 hours and 48 hours respectively. ¹H NMR and ¹³C NMR were used for PLLA characterization. GPC and DSC were used to determine the molecular weight and T_g of PLLA. The results showed that by ring-opening polymerization of L-lactide using stannous (II) 2-ethylhexanoate and creatine hydrate as the initiators, PLLA with wide range molecular weight of 10,000-30,000 was obtained. In addition, chain extender was used in this study in order to further increase the molecular weight of PLLA. Toluene 2,4-diisocyanate terminated poly 1,4-butanediol prepolymer could be more effectively used to increase molecular weight of PLLA than 1,6-hexamethylene diisocyanate. Suitable ratio of PLLA to toluene 2,4-diisocyanate terminated poly 1,4-butanediol prepolymer was 1:1.1 and gave T_g at 45.1°C.

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LIST OF ABBREVIATIONS

ROP	: Ring-opening polymerization
CROP	: Cationic ring-opening polymerization
AROP	: Anionic ring-opening polymerization
ACE	: Active chain end
AM	: Activated monomer
FAD	: American Food and Drug Administration
LA	: Lactic acid
LLA	: L-lactide, L,L-Lactide
DLA	: D-lactide, D,D-lactide
PLA	: Polylactide
PLLA	: Poly(L-lactide), Poly(L-lactic acid)
Sn(Oct) ₂	: Stannous 2-ethylhexanoate, Stannous Octoate
HMDI	: 1,6-hexamethylene diisocyanate
NMR	: Nuclear magnetic resonance
GPC	: Gel permeation chromatography

DSC	: Differential scanning calorimetry
\bar{M}_n	: Number-average molecular weight
\bar{M}_w	: Weight-average molecular weight
MWD	: Molecular weight distribution
PDI	: Polydispersity index