

**MICROSCOPIC AND MACROSCOPIC CRYSTALLIZATION KINETICS
OF POLY (3-HYDROXYBUTYRATE) AND ITS BLENDS**

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ABSTRACT

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Concerns for environmental problems are globally increasing. Due to their potential role in biomedical applications, biodegradable polymers are becoming increasingly important worldwide; so, poly (3-hydroxybutyrate) is one of the most important sources. On the other hand, in order to have temperature stability and environmental suitability, it is important to study and control the crystallinity of the polymers. Therefore, the non-isothermal melt and cold crystallization kinetics of poly (3-hydroxybutyrate) (PHB) with poly (lactic acid) (PLA) prepared by precipitation have been investigated using a differential scanning calorimeter (DSC) over the desired range of temperatures where they are found to be miscible. The non-isothermal crystallization kinetics was studied by using various macrokinetic models, namely the Avrami, Tobin, and the Ozawa models. The kinetics was derived by a direct fitting of the experimental data. All three models were found to describe the experimental data fairly well. Moreover, the effective energy barrier for the non-isothermal crystallization process of these blends was analyzed by the differential iso-conversional method of Friedman. Isothermal crystallization kinetics was investigated using both (DSC) and polarized light microscopy (POM). The overall crystallization and spherulitic growth rates were found to increase with decreasing crystallization temperature, T_c . Various macrokinetic models, namely the Avrami, Malkin, and the Urbanovici-Segal models could describe the experimental data fairly well. In the same miscible range and the same cooling condition, PHB97.5/PLA2.5 showed the highest amount of crystallization rate and growth rate in comparison to the other compounds.

บทคัดย่อ

ไซแนบ ซีอี: การศึกษาพลังงานจลน์ของการตกผลึกในระดับจุลภาคและระดับมหภาคของพอลิไฮดรอกซีอัลคาโนเอตและพอลิเมอร์ผสม (Microscopic and Macroscopic Crystallization Kinetics of Poly (3-hydroxybuturate) and its blends) อ. ที่ปรึกษา: รศ. ดร.พิชญ์ สุภผล 109 หน้า ISBN 974-9990-10-2.

เนื่องจากค่านึงถึงปัญหาทางด้านสิ่งแวดล้อมและประโยชน์ทางด้านชีวเวชศาสตร์ พอลิเมอร์ที่ย่อยสลายทางชีวภาพจึงมีความสำคัญมากยิ่งขึ้น ซึ่งพอลิไฮดรอกซีบิวทีเรตนั้นเป็นพอลิเมอร์ที่ย่อยสลายทางชีวภาพที่สำคัญ ในทางกลับกัน การศึกษาและควบคุมการตกผลึกก็มีความสำคัญสำหรับความเหมาะสมของอุณหภูมิและเสถียรภาพทางสิ่งแวดล้อมของพอลิเมอร์ ดังนั้น งานวิจัยนี้จึงใช้ differential scanning calorimeter (DSC) ศึกษาพลังงานจลน์ของการตกผลึกจากพอลิเมอร์เหลวและจากพอลิเมอร์ในสภาพแก้วแบบนอนไอโซเทอร์มอลในช่วงอุณหภูมิที่พอลิเมอร์ทั้งสองผสมเข้ากันได้ของพอลิเมอร์ผสมระหว่างพอลิไฮดรอกซีบิวทีเรตกับพอลิแลคติกแอซิดที่ถูกเตรียมจากการตกตะกอน รวมทั้งสัณฐานวิทยาของสเฟียรูไลต์ถูกวิเคราะห์โดยกล้องจุลทรรศน์แสงโพลาไรด์ พบว่าในการศึกษาพลังงานจลน์ของการตกผลึกแบบนอนไอโซเทอร์มอลสามารถอาศัยแบบจำลองของ อรามิ, โทบิน, และโอซาวามาอธิบายผลการทดลองได้ นอกจากนี้ งานวิจัยนี้ศึกษาพลังงานประสิทธิผลสำหรับด้านกระบวนการการตกผลึกแบบนอนไอโซเทอร์มอลของพอลิเมอร์ผสมถูกวิเคราะห์ตามวิธีของเฟรดแมน รวมทั้งยังนำ DSC และกล้องจุลทรรศน์แสงโพลาไรด์มาศึกษาถึงพลังงานจลน์ของการตกผลึกแบบไอโซเทอร์มอล พบว่าการตกผลึกทั้งหมดและอัตราการเติบโตของสเฟียรูไลต์เพิ่มขึ้นเมื่ออุณหภูมิของการตกผลึกเพิ่มขึ้นซึ่งสามารถนำแบบจำลองของ อรามิ, มาลคิน, และเออบาโนวิกิ-ซีกอลมาใช้อธิบายผลของการทดลองดังกล่าวได้ และพบว่าพอลิเมอร์ผสมระหว่างพอลิไฮดรอกซีบิวทีเรตกับพอลิแลคติกแอซิดในอัตราส่วน มีปริมาณการตกผลึกและอัตราการเติบโตของผลึกเร็วที่สุดในบรรดาพอลิเมอร์ผสมที่อัตราส่วนอื่น

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