

**CRYSTALLIZATION KINETICS OF  
POLY(TRIMETHYLENE TEREPHTHALATE)  
: MACROSCOPIC AND MICROSCOPIC STUDIES**



Mr. Nattapol Apiwanthanakorn

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**By:** Mr. Nattapol Apiwanthanakorn  
**Program:** Polymer Science  
**Thesis Advisors:** Asst. Prof. Pitt Supaphol  
Dr. Manit Nithitanakul

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*K. Bunyakiat.*  
..... College Director  
(Assoc. Prof. Kunchana Bunyakiat)

**Thesis Committee:**

*Pitt Supaphol*  
.....  
(Asst. Prof. Pitt Supaphol)

*Manit Nithitanakul*  
.....  
(Dr. Manit Nithitanakul)

*Anuvat Sirivat*  
.....  
(Assoc. Prof. Anuvat Sirivat)

*Ratana Rujiravanit*  
.....  
(Asst. Prof. Ratana Rujiravanit)

**ABSTRACT**

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Macroscopic crystallization kinetics was investigated using differential scanning calorimetry (DSC). Non-isothermal crystallization of poly(trimethylene terephthalate) (PTT) was considered in this study. The kinetics of crystallization process was evaluated by the macrokinetic models, namely Avrami, Tobin, Ozawa, Ziabicki. The effective energy barrier was determined by the differential isoconversional method of Friedman. For the crystallization from the melt state, the evaluated crystallization rate was found to increase as the cooling rate increased. In case of the crystallization from the glassy state, the evaluated crystallization rate was found to increase as heating rate increased. Moreover, the miscibility, melting, crystallization kinetics behavior, and morphologies of PTT/PEN blends were also studied. A single composition-dependent glass transition temperature ( $T_g$ ) was observed in these blends system, implying that these blends are fully miscible in the amorphous phase. The subsequent melting endotherms after melt-crystallization exhibited the melting point depression behavior in which the observed melting temperatures decreased with an increasing amount of minor component of the blends. Isothermal melt-crystallization kinetics was considered both macroscopically (using DSC) and microscopically (using polarized light microscopy (PLM)). The overall crystallization and spherulitic growth rates were found to increase with increasing crystallization temperature  $T_c$ . Considering at the same undercooling, the overall rates were found to increase with increasing PEN contents while the growth rates in blends were unaffected by composition. The morphologies of blends depend on both  $T_c$  and composition.

## บทคัดย่อ

ณัฐพล อภิวันทนากร: จลนศาสตร์ของการเกิดผลึกของพอลิไตรเมธิลีนเทเรฟทาเลต: ศึกษาในระดับมหภาคและจุลภาค (Crystallization Kinetics of Poly(trimethylene terephthalate): Macroscopic and Microscopic Studies) อ.ที่ปรึกษา: ผศ. ดร.พิชญ์ สุภผล และ ดร.มานิตย์ นิธิธนากุล 165 หน้า ISBN 974-9651-60-x

จลนศาสตร์มหภาคของการเกิดผลึกถูกติดตามโดยใช้เทคนิค DSC ซึ่งในการศึกษานี้ พิจารณาการเกิดผลึกในสถานะที่อุณหภูมิไม่คงที่ จลนศาสตร์ของกระบวนการเกิดผลึกถูกประเมินโดยแบบจำลองจลนศาสตร์มหภาคซึ่งได้แก่ Avrami Tobin Ozawa และ Ziabicki ค่าพลังงานกีดขวางที่เกี่ยวข้องถูกวัดโดย differential isoconversional method ของ Friedman สำหรับการเกิดผลึกจากสถานะหลอมเหลวนั้นพบว่า อัตราการเกิดผลึกที่ถูกประเมินเพิ่มขึ้นเมื่อเพิ่มอัตราการเย็นตัว ในกรณีเกิดผลึกจากสถานะคล้ายแก้ว อัตราการเกิดผลึกที่ประเมินได้ถูกพบว่าเพิ่มขึ้นเมื่อเพิ่มอัตราการให้ความร้อน นอกจากนี้ยังได้ศึกษาความเข้ากันเป็นเนื้อเดียว พฤติกรรมการหลอมเหลวและการเกิดผลึก และ อัญรูปของพอลิเมอร์ผสมระหว่างพอลิไตรเมธิลีนเทเรฟทาเลตกับพอลิเอธิลีนแนฟทาเลต ในระบบพอลิเมอร์ผสมนี้แสดงอุณหภูมิการเปลี่ยนสถานะคล้ายแก้วค่าเดียว และอุณหภูมินี้จะเปลี่ยนแปลงเมื่ออัตราส่วนของพอลิเมอร์ผสมเปลี่ยนแปลงไป แสดงให้เห็นว่าพอลิเมอร์ผสมเหล่านี้สามารถผสมเข้ากันได้ ในสถานะอสัณฐาน การให้ความร้อนเพื่อสังเกตพฤติกรรมการหลอมเหลวหลังจากทำให้เกิดผลึก ณ อุณหภูมิคงที่ พบว่าอุณหภูมิของการหลอมเหลวลดลงเมื่อเพิ่มองค์ประกอบที่มีอยู่น้อยในพอลิเมอร์ผสม จลนศาสตร์ของการเกิดผลึกจากสถานะหลอมเหลว ณ อุณหภูมิคงที่ที่ถูกพิจารณาทั้งระดับมหภาค (โดย DSC) และจุลภาค (โดย PLM) พบว่าอัตราการเกิดผลึกโดยภาพรวมและอัตราการเติบโตของผลึกเพิ่มขึ้นเมื่อเพิ่มอุณหภูมิของการเกิดผลึก เมื่อพิจารณาแต่ละองค์ประกอบของพอลิเมอร์ผสม ณ ผลต่างระหว่างอุณหภูมิลหลอมเหลวกับอุณหภูมิจากการเกิดผลึกที่เท่ากัน พบว่าอัตราการเกิดผลึกโดยรวมเพิ่มขึ้นเมื่อเพิ่มปริมาณของพอลิเอธิลีนแนฟทาเลต ขณะที่องค์ประกอบที่เปลี่ยนแปลงที่ใช้ช่วงการศึกษานี้ ไม่มีผลต่ออัตราการเติบโตของผลึกในพอลิเมอร์ผสม อัญรูปของพอลิเมอร์ผสมขึ้นกับทั้งอุณหภูมิของการเกิดผลึกและองค์ประกอบของพอลิเมอร์ผสม

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