

การพัฒนาโคพอลิเมอร์ เบนซอกซาซีน/อีพอกซี ที่เสริมแรงด้วยเส้นใยแก้ว
สำหรับแผ่นวงจรพิมพ์



นายหารณรงค์ ทองคลี

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิศวกรรมศาสตรมหาบัณฑิต
สาขาวิชาวิศวกรรมเคมี ภาควิชาวิศวกรรมเคมี
คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2552
ลิขสิทธิ์ของจุฬาลงกรณ์มหาวิทยาลัย

DEVELOPMENT OF FIBER GLASS-REINFORCED BENZOXAZINE/EPOXY
COPOLYMERS FOR PRINT CIRCUIT BOARD (PCB'S)

Mr. Hannarong Thongklee

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Engineering Program in Chemical Engineer

Department of Chemical Engineering

Faculty of Engineering

Chulalongkorn University

Academic Year 2009

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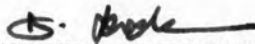
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BENZOXAZINE/EPOXY COPOLYMERS FOR PRINT CIRCUIT
BOARD (PCB'S)

By Mr. Hannarong Thongklee

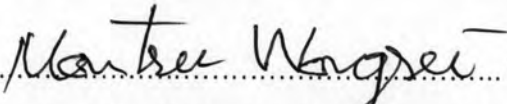
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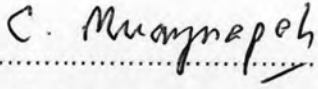
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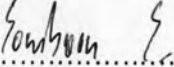
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 สำหรับแผ่นวงจรพิมพ์ (DEVELOPMENT OF FIBER GLASS-REINFORCED
 BENZOXAZINE/EPOXY COPOLYMERS FOR PRINT CIRCUIT BOARD (PCB'S))
 อ. ที่ปรึกษาวิทยานิพนธ์หลัก : รศ. ดร. สราวุธ ริมคูสิต, 89 หน้า.

การศึกษาถึงคุณสมบัติทางความร้อน และคุณลักษณะกระบวนการผลิตของเบนซอก
 ซาซีนเรซินที่สังเคราะห์มาจากบิสฟีนอลเอ โดยการเติมอีพอกซีชนิด โนโวแลคลงในเบนซอก
 ซาซีนเป็นโพลีเมอร์ผสมร่วมตามสัดส่วนต่างๆ เพื่อการเสริมแรงด้วยเส้นใยแก้วชนิด E-glass
 สำหรับการทำเป็นแผ่นแผงวงจรร่วม การศึกษาในครั้งนี้ได้ใช้เครื่อง Rheometer วิเคราะห์หา
 ช่วงความกว้างของอุณหภูมิในขบวนการขึ้นรูปชิ้นงาน จุดหลอมเหลวของเรซินผสมร่วม และ
 จุดที่เริ่มเป็นเส้นใยของโพลีเมอร์ จากการวิเคราะห์ของ Rheometer พบว่าค่าที่ได้ทั้งหมดจะ
 ชยับไปที่อุณหภูมิสูงขึ้นตามสัดส่วนการผสมของ โนโวแลคอีพอกซีเรซิน สำหรับการวิเคราะห์
 หาอุณหภูมิการบ่มตัวได้ใช้เครื่อง DSC วิเคราะห์หาคุณลักษณะการบ่มตัว และสถานะคล้าย
 แก้วของโพลีเมอร์ผสมร่วม พบว่าอุณหภูมิในการบ่มตัวเป็นลักษณะการคายความร้อนแบบจุด
 เดียวที่อุณหภูมิ 250°C จากการศึกษาครั้งนี้ปรากฏว่าเมื่อเพิ่มสัดส่วนการผสมของอีพอกซีทำให้
 อุณหภูมิในการบ่มตัวชยับสูงขึ้นตามส่วนการผสมของ โนโวแลคอีพอกซีเรซิน จากการทดสอบ
 สมบัติเชิงกลและสมบัติทางความร้อนพบว่ามีค่าเพิ่มขึ้นเช่นกันเมื่อเพิ่มสัดส่วนของ โนโวแลคอี
 พอกซีเรซิน เมื่อทำการเสริมแรงด้วยแรงด้วยเส้นใยแก้วที่ 80 เปอร์เซ็นต์ ของเส้นใยแก้ว
 สามารถเพิ่มสมบัติเชิงกลและสมบัติทางความร้อนมีค่าเพิ่มขึ้น และค่าสัมประสิทธิ์การขยายตัว
 ของความร้อน ที่ช่วงอุณหภูมิจาก 20°C ถึง 130°C มีค่าลดลงจาก ที่ 46.8 ppm/°C ต่ำลงมาที่
 24.26 ppm/°C

ภาควิชา วิศวกรรมเคมี
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4971484721 : MAJOR CHEMICAL ENGINEERING

KEYWORDS : BENZOXAZINE/EPOXY COPOLYMERS / FIBER GLASS-REINFORCED
/ PRINT CIRCUIT BOARD (PCB'S) / THERMOMECHANICAL PROPERTIES

HANNARONG THONGKLEE : DEVELOPMENT OF FIBER GLASS-
REINFORCED BENZOXAZINE/EPOXY COPOLYMERS FOR PRINT CIRCUIT
BOARD (PCBs). THESIS ADVISOR: ASSOC.PROF. SARAWUT RIMDUSIT,
Ph.D, 89 pp.

Bisphenol-A based benzoxazine resin was copolymerized with novolac epoxy resin in order to study the effect of composition ratio on processing behaviors, thermophysical properties of the resulting copolymers. The copolymers were further reinforced with glass fiber (E-glass) and were characterized for an application as printed circuit boards (PCB's). Rheometer was used to determine the processing window of the resin mixtures. The liquefying point and gel point to liquid of the resin mixtures increased with increasing amount of novolac epoxy while the processing window of the mixtures was found to shift to higher temperature range. Cure behaviors and glass transition temperature of the copolymer were studied using differential scanning calorimeter (DSC) which indicated a single exothermic curing peak at 250°C. The experimental results also revealed that the curing temperature of the copolymers shifted to higher value as the fraction of the novolac epoxy in the resin mixtures increased. Thermal and mechanical properties were found to systematic increase with novolac epoxy composition. The fiber glass-reinforced with about 80% by weight of glass fiber. The reinforced matrix systems show that the better in flexural properties and the thermal expansion behavior of fiber glass-reinforced polybenzoxazine and epoxy copolymers specimens was measured from 30 to 120°C indicated that the coefficient thermal expansion was reduced from 46.8 ppm/°C to 24.26 ppm/°C.

Department : CHEMICAL ENGINEERING

Field of Study : CHEMICAL ENGINEERING

Academic Year : 2009

Student's Signature

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Chulalongkorn University

Academic Year 2009

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ACKNOWLEDGEMENTS

The author would like to express sincere gratitude and deep appreciation to my advisor Assoc. Prof. Dr. Sarawut Rimdusit for his vision, intelligence, guidance and kindness throughout the course of this research. Furthermore, I would like to thank the committee of this thesis: Asst. Prof. Dr. Montree Wongsri, Assoc. Prof. Dr. Chirakarn Muangnapoh and Dr. Somboon Sahasithiwat for the kind advices and comments.

Bisphenol A for benzoxazine resin was kindly supplied by Thai Polycarbonate Co., Ltd, Thai Organic Chemicals Co., Ltd (Epoxy Division) for Novolac epoxy sample and Neotech Inspection & Chemical Co., Ltd for glass-fiber (E-glass) contribution are gratefully acknowledged.

Additionally, thanks to my entire colleague and everyone in the polymer engineering laboratory, Chulalongkorn University, for their discussion and friendly encouragement. Finally, I would like to thank, from the bottom of my heart, my parents who always give their unfailing love, understanding, and generous encouragement throughout my entire study.

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