

**DEVELOPMENT OF ANHYDROUS PROTON EXCHANGE MEMBRANE  
FUEL CELL (PEMFC): AN INVESTIGATION OF MOLECULAR DESIGN  
AND SYNTHESIS OF MODEL COMPOUNDS**



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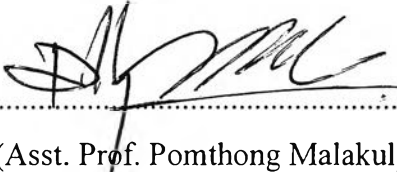
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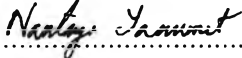
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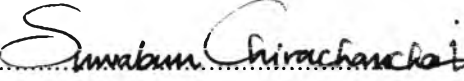
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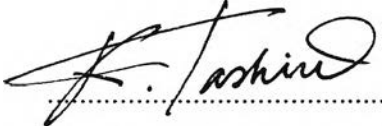
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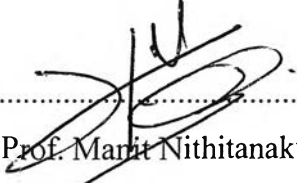
  
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## ABSTRACT

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Puripong Totsatitpaisan: Development of Anhydrous Proton Exchange Membrane Fuel Cell (PEMFC): An Investigation of Molecular Design and Synthesis of Model Compounds.

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Keywords: Fuel cell/ Polymer electrolyte membrane fuel cell/ PEMFC/ Proton conducting/ Proton transferring/ Anhydrous/ Water-free/ Heteroaromatic/ Heterocycle/ Imidazole/ Benzimidazole

Benzimidazole-based model compounds are designed and synthesized in a systematic system, i.e., mono-, di- and tri-functional compounds. The characterizations indicate the formation of well-packing structure with hydrogen bond network exhibited in their crystal structures. The temperature dependency studies reveal that the stronger packing structure of the compound is achieved when increasing the number of benzimidazole unit on molecule from mono- to di- and to tri-functional compound. Blending the compounds with sulfonated poly(ether ether ketone) (SPEEK) matrix is found to improve thermal stability and proton conductivity of SPEEK. Comparing between the benzimidazole model compounds, the tri-functional one is the most effective compound giving the highest improvement in both thermal property and proton conductivity to SPEEK membrane. The increase in benzimidazole unit is found to strongly affect the structure of hydrogen bond network from the “isolated channel type” to the “layered interlinked channel type”. The presence of solvent molecules, although, leads to the obstruction of intermolecular hydrogen bond formation, it offers the “solvent assisted intramolecular hydrogen bond network” to the trifunctional benzimidazole compound.

## บทคัดย่อ

กฐินพงศ์ ทศทศไฟศาล : การพัฒนาเซลล์เชื้อเพลิงแบบเมมเบรนแลกเปลี่ยนโปรตอนทีทำงานได้ในสภาวะปราศจากน้ำ: การออกแบบโครงสร้างโมเลกุลและการสังเคราะห์สารต้นแบบเพื่อการส่งผ่านโปรตอน (Development of Anhydrous Proton Exchange Membrane Fuel Cell (PEMFC): An Investigation of Molecular Design and Synthesis of Model Compounds) อ. ทีปริศึกษา : รองศาสตราจารย์ ดร. สุวบุญ จิรชาญชัย และ ศาสตราจารย์ ดร. โคจิ ทาชิโร (Prof. Kohji Tahshiro) 90 หน้า

สารต้นแบบทีมีพื้นฐานมาจากอนุพันธ์ของเบนซิมิดาโซลได้ถูกออกแบบและสังเคราะห์ขึ้นอย่างเป็นระบบ กล่าวคือประกอบด้วยสารหมู่ฟังก์ชันเดี่ยว หมู่ฟังก์ชันคู่ และหมู่ฟังก์ชันสาม ผลการวิเคราะห์บ่งชี้ถึงการจัดเรียงตัวอย่างเป็นระเบียบของโมเลกุลร่วมกับการเกิดร่างแหของพันธะไฮโดรเจนในโครงสร้างผลึกของสารทั้งสามชนิด การศึกษาผลกระทบของอุณหภูมิต่อการจัดเรียงตัวของสารพบว่าการเพิ่มจำนวนหมู่เบนซิมิดาโซลบนโมเลกุลนั้นส่งผลให้โครงสร้างการจัดเรียงตัวของโมเลกุลแข็งแรงขึ้น นอกจากนี้เมื่อนำสารต้นแบบเบนซิมิดาโซลนี้มาผสมกับซัลโฟเนตเตท พอลิ(อีเทอร์ อีเทอร์ คีโตน) พบว่าสารต้นแบบสามารถปรับปรุงคุณสมบัติการทนความร้อนและการเหนี่ยวนำโปรตอนของพอลิเมอร์ให้ดีขึ้นได้ และเมื่อเปรียบเทียบระหว่างสารเบนซิมิดาโซลต้นแบบด้วยกันแล้ว พบว่าโครงสร้างโมเลกุลแบบหมู่ฟังก์ชันสามมีประสิทธิภาพทีสุดในการเพิ่มคุณสมบัติทั้งสองประการเมื่อเทียบกับสารต้นแบบตัวอื่นๆ การเพิ่มจำนวนหมู่เบนซิมิดาโซลบนโมเลกุลยังส่งผลให้โครงสร้างของร่างแหพันธะไฮโดรเจนเปลี่ยนจากแบบ “ช่องทางเดี่ยว” เป็นแบบ “ชั้นถักทอของช่องทางเดี่ยว” และยังพบว่าถึงแม้การมีโมเลกุลของตัวทำละลายในโครงสร้างผลึกจะไปขัดขวางการเกิดพันธะไฮโดรเจนระหว่างโมเลกุลของสารต้นแบบแต่ในกรณีของสารหมู่ฟังก์ชันสามนั้นตัวทำละลายช่วยให้เกิดร่างแหพันธะไฮโดรเจนระหว่างหมู่เบนซิมิดาโซลทั้งสามหมู่บนโมเลกุลได้

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