

**Organic-Inorganic Hybrid Composites and Nanocomposites: An Approach to
Develop Polymer Electrolyte Membranes for Proton Exchange Membrane Fuel
Cells (PEMFCs)**



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ABSTRACT

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Two approaches of organic-inorganic hybrid composite membranes, i.e., (i) inorganic fillers functionalized with Krytox/Nafion[®] composite membranes; and (ii) clay silicate layers functionalized with sulfonic acid groups/ SPEEK (sulfonated polyether ether ketone) composite membranes are proposed for polymer electrolyte membrane fuel cell (PEMFC) applications. For the Nafion[®]-based composite membranes, a Nafion[®]-like-polymer chains, i.e., Krytox 157 FSL (carboxylic acid terminated perfluoropolyether), immobilized onto the surface of inorganic fillers, i.e., silica particles and montmorillonite, via silane coupling agent are designed for modifying filler surface to be miscible with Nafion[®]. The composite membranes prepared by solution casting process showing the proton conductivity maintained in the wide range of temperature up to 130 °C and the homogeneous membrane as observed by SEM proves us successful “like dissolves like” between Nafion[®] polymer chains and Krytox-modified fillers. In the case of the SPEEK-based composite membrane, montmorillonite treated with aminosilane coupling agent followed by reacting with 4-sulfophthalic acid is proposed as an approach to improve methanol crossover reduction and proton conductivity to be a potential material for direct methanol fuel cells (DMFCs).

บทคัดย่อ

ระพี โกศลวิตร : สารผสมอินทรีย์-อนินทรีย์แบบคอมโพสิต และนาโนคอมโพสิต: แนวทางหนึ่งสำหรับการพัฒนาเมมเบรนพอลิเมอร์อิเล็กโทรไลต์ สำหรับเซลล์เชื้อเพลิงชนิดเมมเบรนแลกเปลี่ยนไอออน (Organic-Inorganic Hybrid Composites and Nanocomposites: An Approach to Develop Polymer Electrolyte Membrane for Proton Exchange Fuel Cells (PEMFCs)) อ.ที่ปรึกษา : รองศาสตราจารย์ ดร. สุวบุญ จิราญชัย 122 หน้า

วิทยานิพนธ์ฉบับนี้เสนอ 2 วิธีการในการเตรียมเมมเบรนคอมโพสิตผสมระหว่างสารอินทรีย์ และสารอนินทรีย์สำหรับเซลล์เชื้อเพลิงชนิดแลกเปลี่ยนไอออน ซึ่งประกอบด้วย (1) เมมเบรนคอมโพสิตระหว่างสารอนินทรีย์ที่ถูกรับปรุงโครงสร้างด้วยไครทอกซ์ และนาฟิออน และ (2) เมมเบรนคอมโพสิตระหว่างแรตินขาวที่ปรับปรุงโครงสร้างด้วยหมู่ซัลโฟนิค และซัลโฟเนตพอลิอีเทอร์ อีเทอร์ คีโตน ในกรณีที่ 1 ไครทอกซ์ 157 เอฟเอสแอล (สารประกอบกรดคาร์บอกซิลิกที่ปลายสายโซ่ของเพอร์ฟลูโอโรพอลิอีเทอร์) ซึ่งเป็นสารที่มีโครงสร้างคล้ายนาฟิออน ถูกติดลงบนพื้นผิวของสารอนินทรีย์ได้แก่ ซิลิกา และ มอนท์มอริลโรไนท์ โดยใช้สารผนวกไซเลนในการพัฒนาพื้นผิวของสารอนินทรีย์ เพื่อความเข้ากันได้กับนาฟิออน แผ่นฟิล์มคอมโพสิตเตรียมได้จากการขึ้นรูปของสารละลาย แสดงค่าการนำโปรตอนที่คงที่จนกระทั่งอุณหภูมิสูงถึง 130 °C ความเป็นเนื้อเดียวกันซึ่งแสดงให้เห็นความเข้ากันได้ระหว่างนาฟิออน และสารอนินทรีย์ที่ถูกรับปรุงโครงสร้างด้วยไครทอกซ์ ของแผ่นฟิล์มถูกยืนยันด้วยภาพถ่ายจากกล้องจุลทรรศน์อิเล็กตรอนแบบส่องกราด ในกรณีของเมมเบรนคอมโพสิตของ และซัลโฟเนตพอลิอีเทอร์ อีเทอร์ คีโตน และมอนท์มอริลโรไนท์ที่ถูกรับปรุงโครงสร้างโดยใช้สารผนวกอะมิโนไซเลน ตามด้วยการทำปฏิกิริยากับกรด 4-ซัลโฟพทาสิกนั้น ค่าการซึมผ่านของเมทานอลลดลง และค่าการนำโปรตอนเพิ่มขึ้นซึ่ง แสดงให้เห็นถึงความเป็นไปได้ที่จะใช้เมมเบรนนี้ในเซลล์เชื้อเพลิงชนิดเมทานอล

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