הטכניון - מכון טכנולוגי לישראל

TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY

הפקולטה להנדסה כימית
ע״ש וולפסון
The Wolfson Department of Chemical Engineering

Wolfson Department of Chemical Engineering Seminar

Monday, March 17th, 2025 at 13:30

Zoom: https://technion.zoom.us/j/96298325147

Pore-filling Anion Exchange Membranes in Alkaline Devices

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MSc Final Seminar

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As the energy revolution advances, the development of clean energy sources carries immense expectations. Hydrogen, giving the prospect of carbon neutrality, is increasingly regarded as a promising fuel for a continuous power supply. As such, hydrogen-powered fuel cells (FCs) and hydrogen-producing water electrolyzers (WEs) have attracted substantial research interest as emerging energy conversion devices in recent years. Anion exchange membranes (AEMs), recognized as the paramount cores in polymer-based FCs and WEs, serve as both separator diaphragm and ion transport medium to transport hydroxide ion (OH^-) from one side to the other. Owing to their cost-effectiveness and sustainability being liberated from fluorinated polymers, they are becoming a competitive alternative comparing to the prevalent proton exchange membranes. In addition, by working with AEMs, an alkaline environment eliminates the need for precious metal catalysts commonly required in strongly acidic conditions. This advantage significantly lowers overall costs, paving the way for the transition of alkaline devices from the laboratory to commercial applications. Yet, to fulfill the requirements for widespread use, AEMs must strike the delicate balance between excellent electrochemical properties and good mechanical stability. While high OH^- conductivity has been reached after decades of considerable efforts, the improvement of mechanical stability is expected to be forwarded more attention to obtain a durable AEM and hence prolonged lifespan devices.

Pore-filling method, as a novel technique distinguished from conventional casting method, provides a facile way to manage the trade-off between mechanical strength and ion conductivity. It develops AEMs by impregnating polyelectrolyte into substrate with macropores, whereby the former determines the electrochemical properties of AEMs, the latter contributes to their mechanical properties. In this work, a series of pore-filling AEMs that incorporated with poly (vinylbenzyl trimethylamine chloride-co-divinylbenzene) were developed based on porous polyethylene substrates by *in-situ* pore-filling methods. The effects of substrates with various thickness and crosslinking ratios of the monomer solution were investigated. Two techniques including both regular impregnation and vacuum-driven were applied and compared. As-prepared thin pore-filling AEMs exhibited ultra-high mechanical strength (> 100 MPa) without an expense of good conductivity, showing excellent performance both in FCs and WEs with an outstanding longevity.