INNOVATION PARTNERSHIPS
UNIVERSITY OF MICHIGAN

Cross-linked anion-exchange membranes with ultrahigh charge densities

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OVERVIEW

A method for improved ion transport and permselectivity in ion-exchange membranes (IEMs)

- Scalable synthesis of ion exchange membranes for water treatment and energy applications
- Ultrahigh charge densities result in unmatched combination of high permselectivity with high ion conductivity

BACKGROUND

Ion-exchange membranes (IEMs) used in water treatment and energy applications selectively transport ions of a given charge (positive or negative) and prevent the crossover of oppositely charged ions and other undesirable species. Current commercial IEMs are inadequate for non-traditional, highly impaired water sources (e.g., brines, produced flowback water) and are also a limiting factor in energy applications. Improved rates of ion transport and greater permselectivity are required for these demanding applications.

INNOVATION

Researchers at the University of Michigan have developed a new synthetic methodology that provides access to a new class of IEMS with greater charge density and lower water uptake values. The approach utilizes inexpensive, commercially available starting materials that are cost-competitive with those used to produce current IEMs. The membrane fabrication process can be scaled up and is compatible with current production lines. The strategy is applicable to a variety of cross-linkers, allowing for optimization for specific applications. The resulting IEMs display ultrahigh charge densities, and the material performances are unprecedented - exceeding both the selectivity and throughput of conventional IEMs. This is particularly impressive given that many of the physical properties of IEMs (permselectivity, ion conductivity,

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Energy, Infrastructure and Environment
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Innovation Spotlight/Kamcev Lab: Ion-Exchange Membrane Solutions for Sustainability

Inventor
David Kitto
Jovan Kamcev

Further information
Jeremy Nelson
jernelso@umich.edu

View online

water content, charge density) are inversely correlated. Improvements in one property typically require a decrease in at least one other. The University of Michigan synthetic strategy avoids such tradeoffs and represent a truly step-change improvement in IEM performance. The researchers have demonstrated this approach with anion exchange membranes (AEMs), though the approach may also be applicable to cation exchange membranes (CEMs).