

# Ionic Conductive Polymers of Intrinsic Microporosity for Desalination, Power Generation, and Resource Recovery



**Sohum K Patel**  
skpatel5@mit.edu



Yein Yoon<sup>1</sup>, Thomas Goodwin<sup>1</sup>, John Vergados<sup>1</sup>, Zachary P. Smith<sup>1</sup>, Joao Crespo<sup>2</sup>

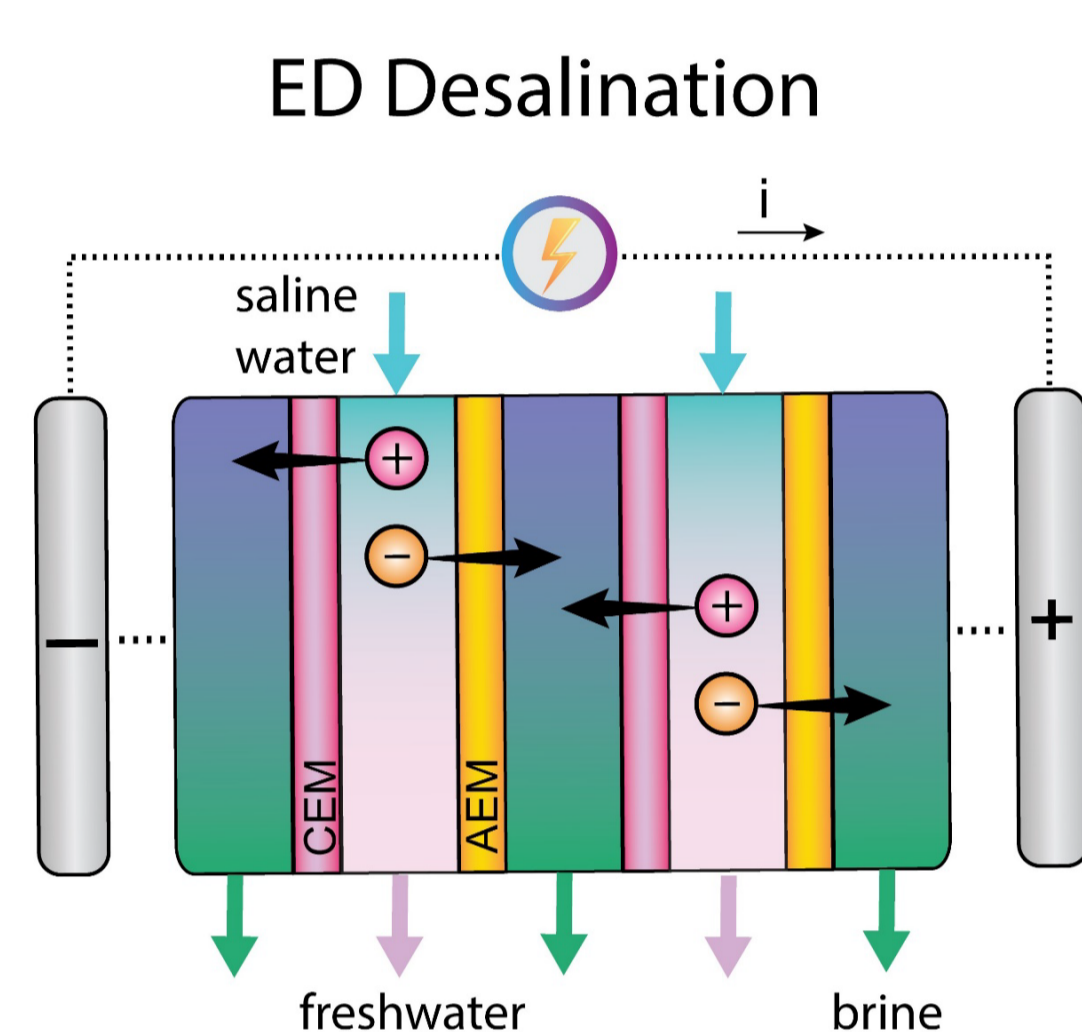
1. Department of Chemical Engineering, Massachusetts Institute of Technology
2. Department of Chemical and Biological Engineering, NOVA University Lisbon

**IDEAS TO IMPACT**

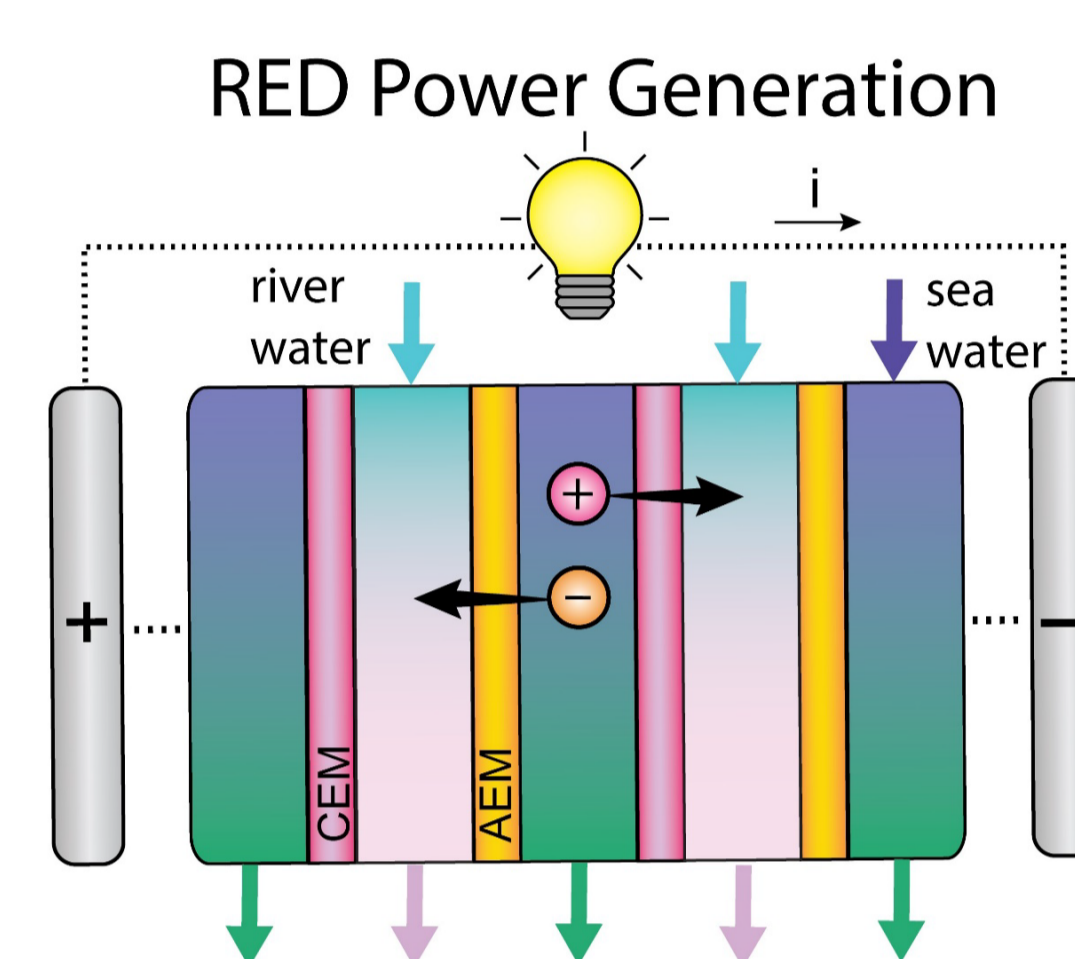
MIT Portugal  
2024 Annual Conference

Addressing the major challenges at the water-energy nexus (i.e., water scarcity, critical element recovery, and clean energy generation and storage), fundamentally requires the separation of ionic species from complex solutions. We are working on developing a novel class of ion-exchange membranes (IEMs) with the potential to vastly improve the efficiency of such ion separations. Our approach is based on the use of polymers of intrinsic microporosity (PIMs), a unique class of materials which enables unprecedented control and decoupling of key membrane physicochemical properties (i.e., water uptake, fixed charge density, porous structure) which govern process scale performance.

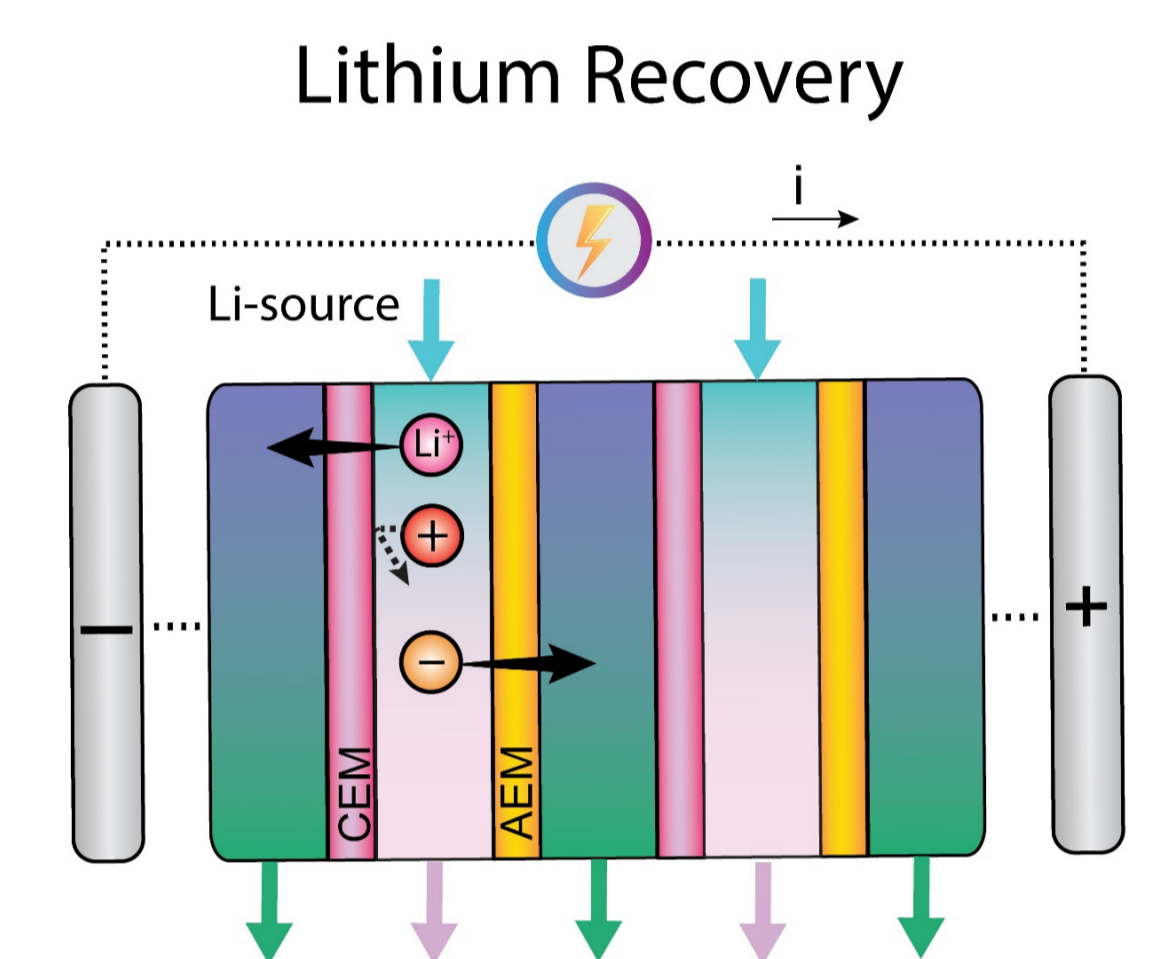
## Novel, High Performance Ion-Exchange Membranes are Critically Needed



**Performance Limiting IEM Properties:**  
High Resistance  
Low Permselectivity



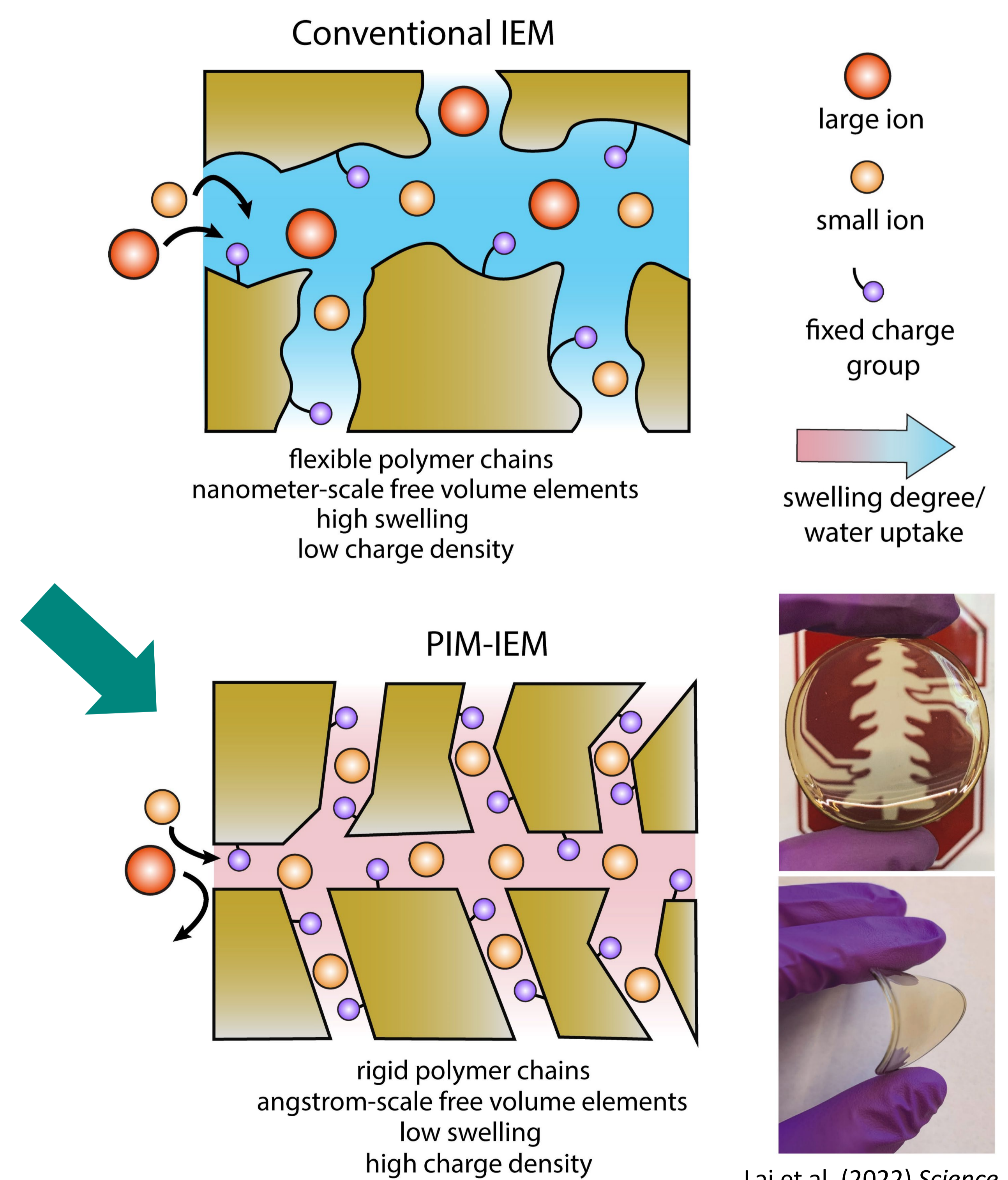
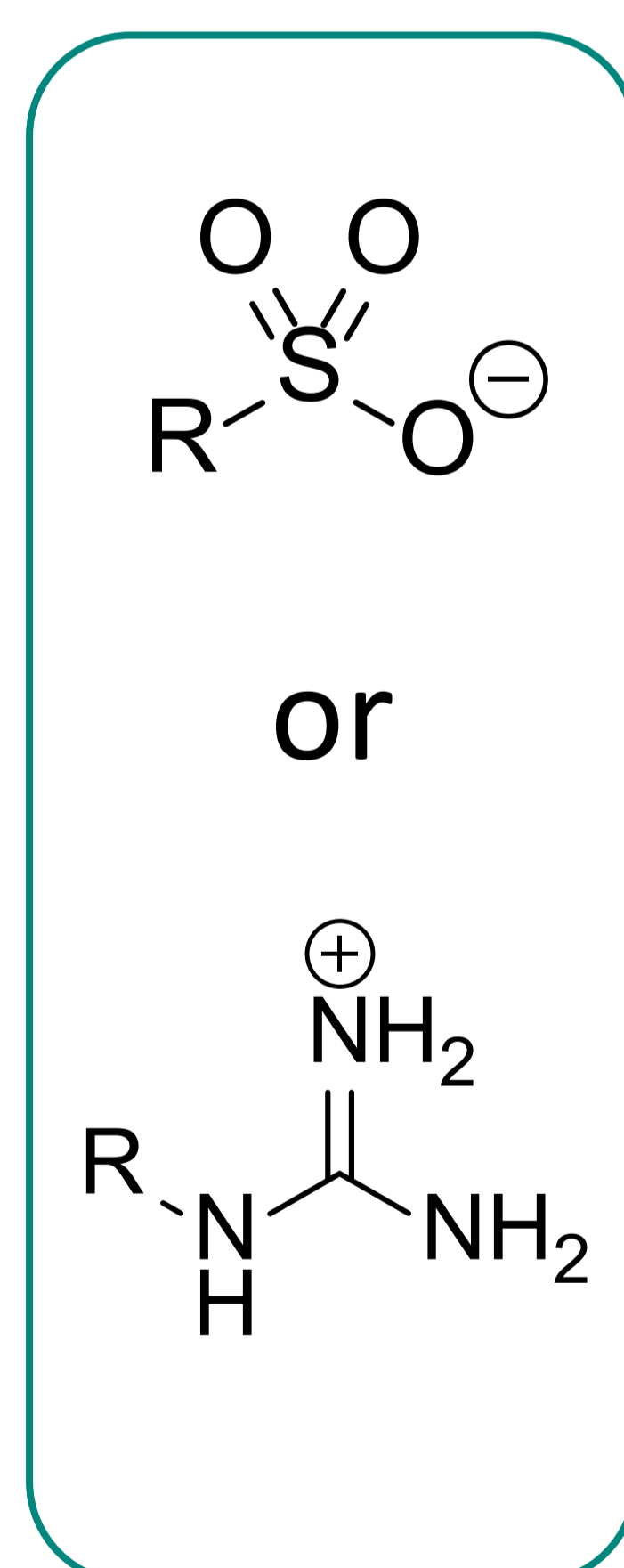
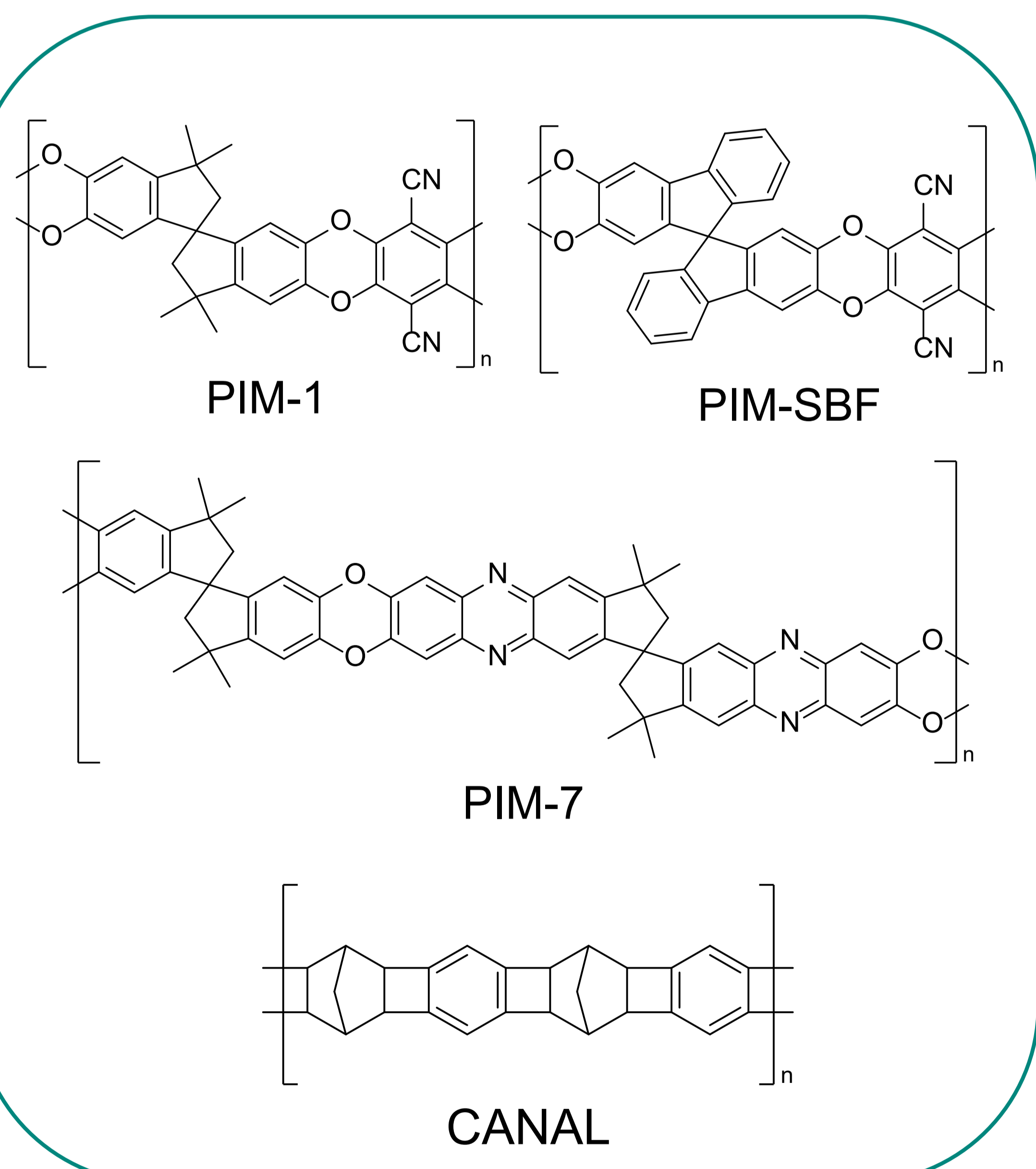
**Performance Limiting IEM Properties:**  
High Resistance  
Low Permselectivity  
High water transport



**Performance Limiting IEM Properties:**  
Large pore size  
High water uptake (swelling)

The properties of current IEMs are insufficient, limiting the efficiency of electrodesalination (ED) desalination, reverse electrodesalination (RED) power generation, and selective resource extraction (e.g., lithium harvesting)

## PIM-IEMs Overcome Challenges of Conventional Materials



The unique structural characteristics of PIMs enables simultaneous control of fixed charge density and pore structure, while conventional polymers are unable to adequately decouple these performance governing properties.

Lai et al. (2022) *Science*

Co-funded by:

