Polymer of Intrinsic Microporosity Enabled pH-Responsive Adsorptive Membrane: Selectivity and Mechanism

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Research Motivation

20% Water Pollution

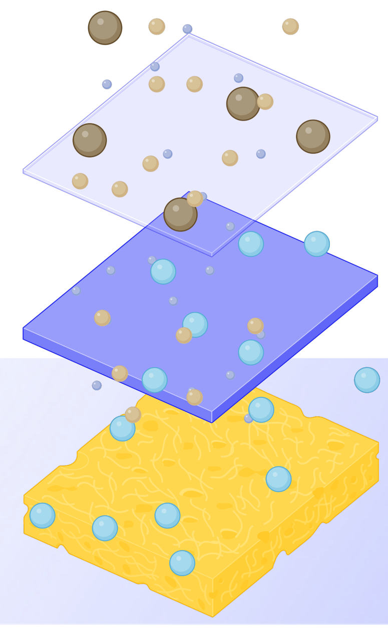
- Synthetic dyes causes detrimental risks towards **aquatic, terrestrial** and **human**

6 Clean Water and Sanitation

- **Support UN Sustainable Development Goal**

Pressure-driven membrane tech.

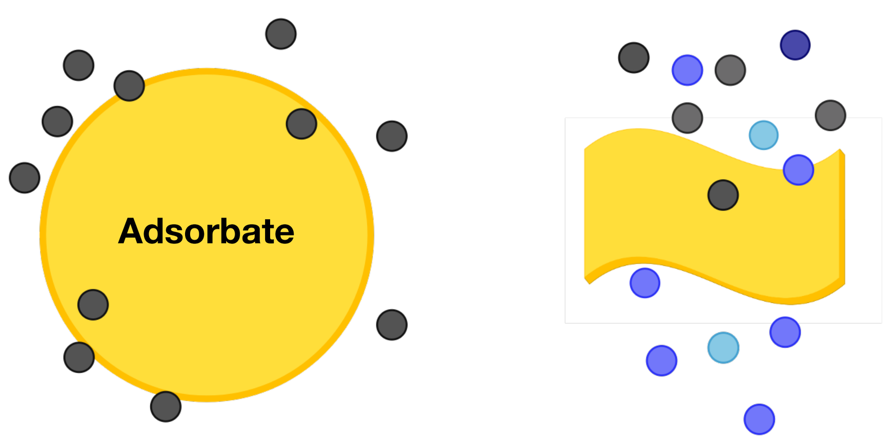
- **Cost effective**
- **Simple operating**
- **mechanism**



Challenges: High energy demand, Selectivity/permeance, Fouling issues

Design and Optimisation of Membrane Fabrication

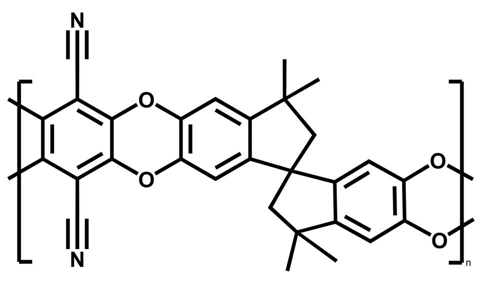
Adsorptive membrane



The adsorptive membrane will possess

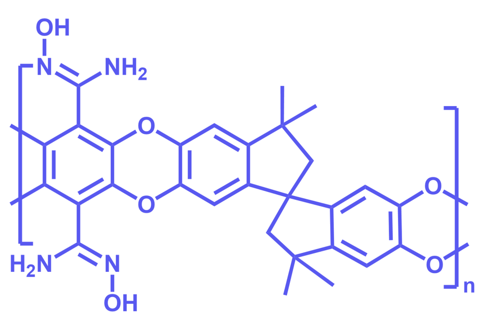
- **Higher** removal rate
- **Higher** permeance
- **Lower** energy demand
- **Regenerative** abilities

Material selection



Polymer of intrinsic microporosity (PIM-1)

- PIM-1 is a novel material with exceptional absorption capacity (~800 m²/g).
- Low processability
- Hydrophobic



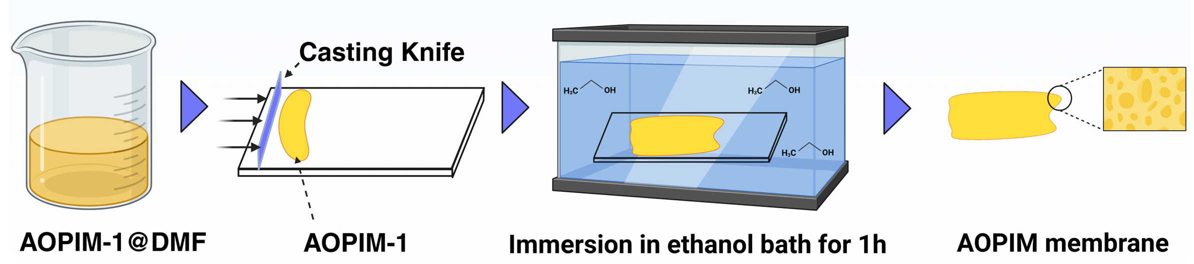
Amidoxime-modified PIM-1 (AOPIM)

- Modified PIM-1 have sufficient absorption capacity (~500 m²/g).
- **High** processability
- **Hydrophilic**
- **pH-responsive**

Membrane fabrication

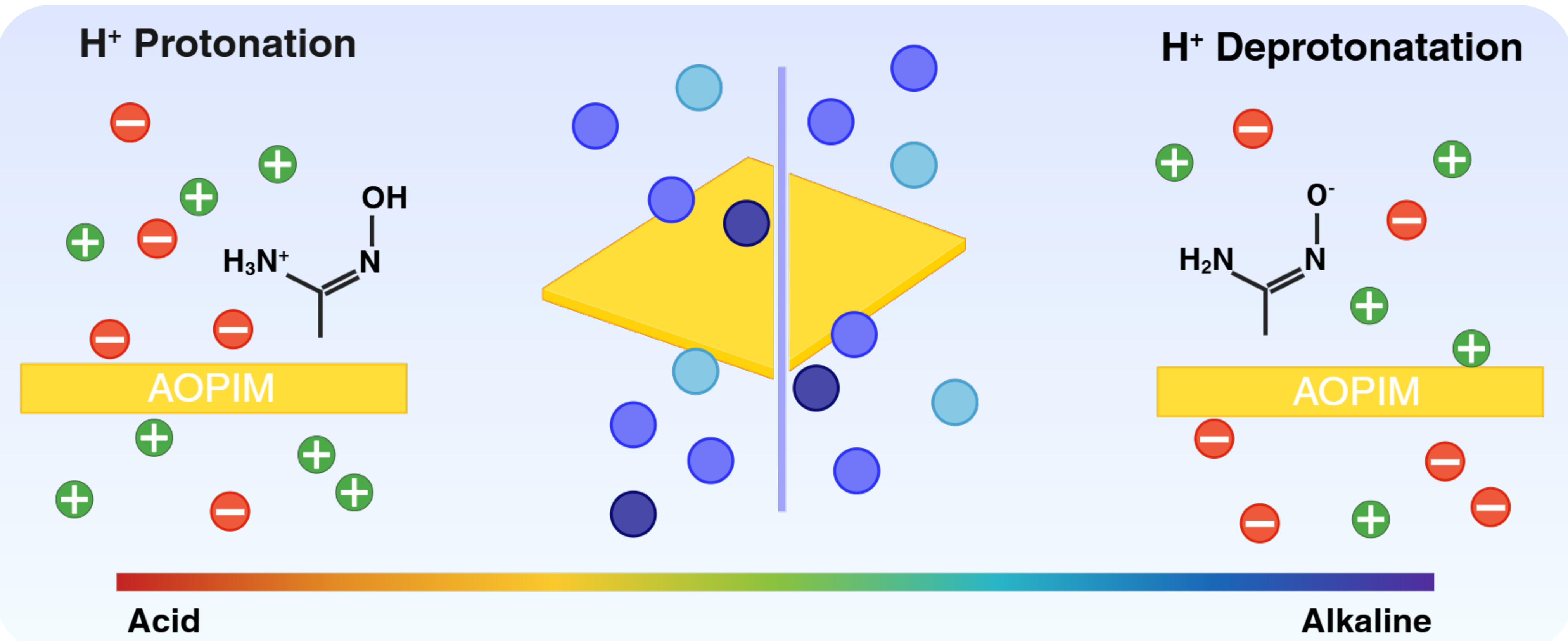
Non-induced solvent phase separation (NIPS)

- AOPIM is dissolved in N,N-dimethylformamide (DMF).
- AOPIM solution is casted on top of a glass substrate.
- The casted membrane is immersed in ethanol for an hour.
- AOPIM membrane is formed.

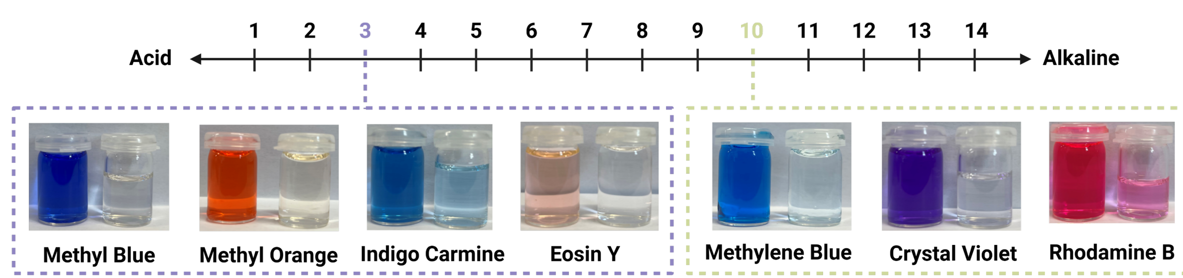


Adsorptive Membrane: Characteristics and Performance

Adsorptive AOPIM membrane



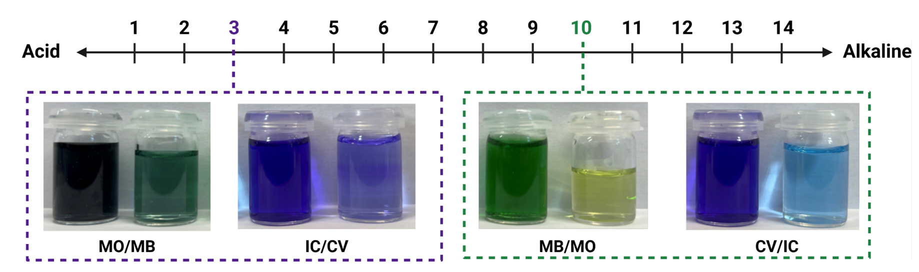
Membrane filtration performance



Single charged dye filtration

High permeance: >94 L/m²·h·bar

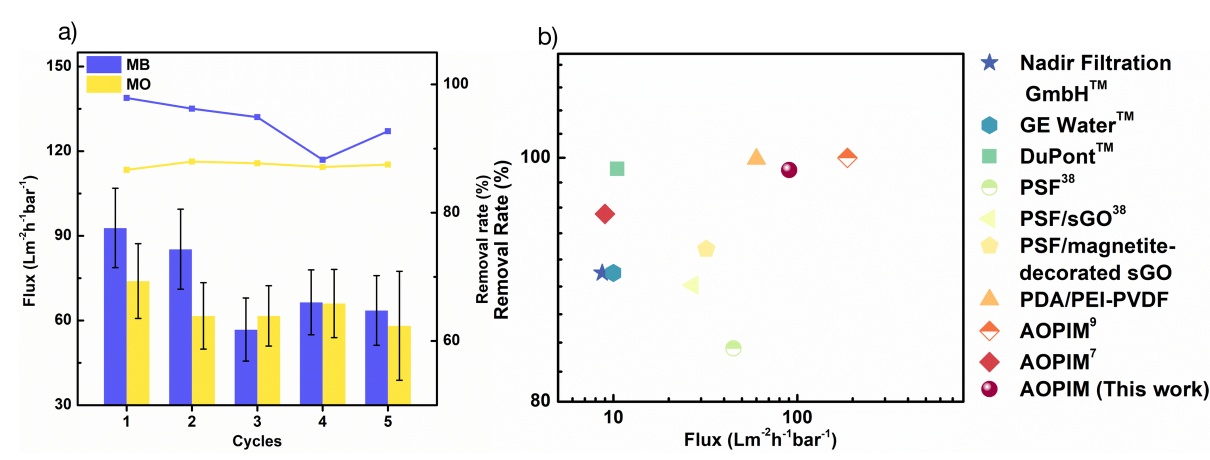
Removal rate: 80% (- dyes), 99% (+ dyes)



Dual charged dye filtration

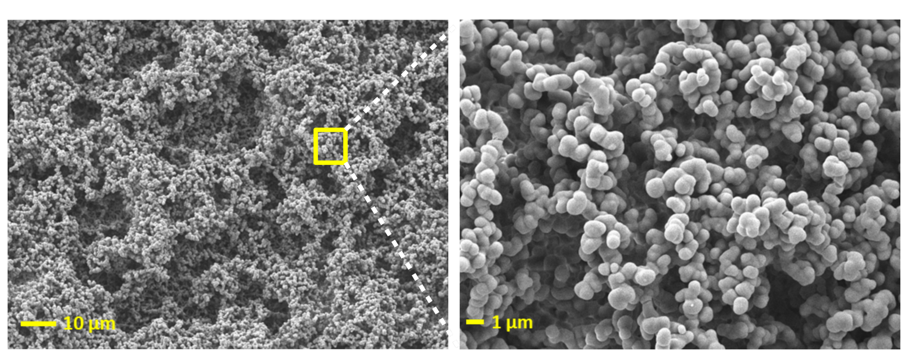
High permeance: >80 L/m²·h·bar

Dye selectivity: 0.3 (Target dye/Total dye)



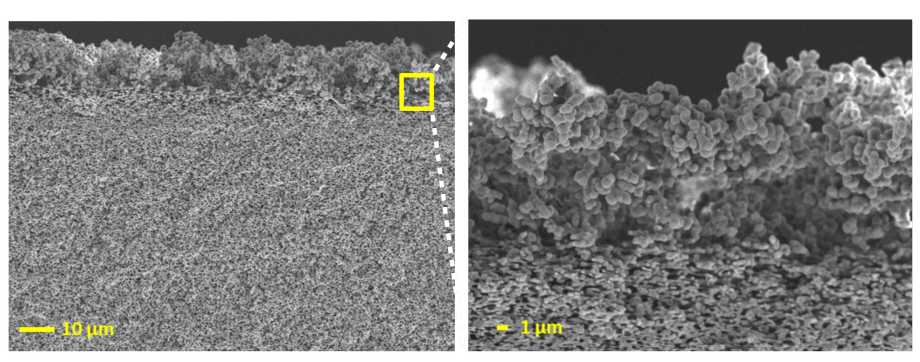
(a) Reusability of AOPIM membrane and (b) Comparison between commercial and AOPIM membrane

Membrane structure and morphology



Surface morphology

Rougher surface than of traditional membranes, increases **specific surface area.**



Cross-section

Spongy structure increases **tortuosity** (dye retention time)

Adsorptive Membrane Manifests High Yet Smart Selectivity.

Reference

[1] Loh *et al.*, "Polymer of Intrinsic Microporosity Enabled pH-Responsive Adsorptive Membrane: Selectivity and Mechanism", *ACS Appl. Eng. Mater.* 2024, 2, 2, 404–414

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