Particle Growth in Mixed Matrix Polymer Membranes: Using Ultra-Small Angle Neutron Scattering to Observe Transient Phenomena in Casting Solutions

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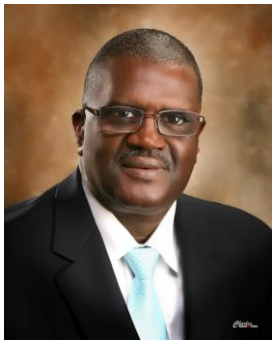
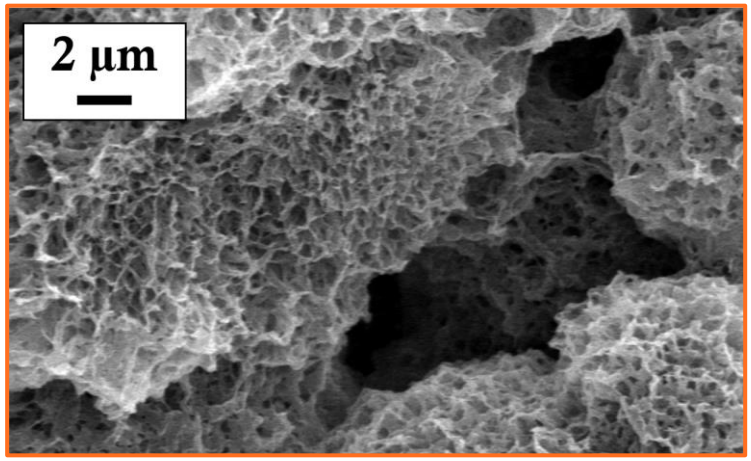
Caltech

Mixed matrix membranes with *in-situ* generated polymeric particles

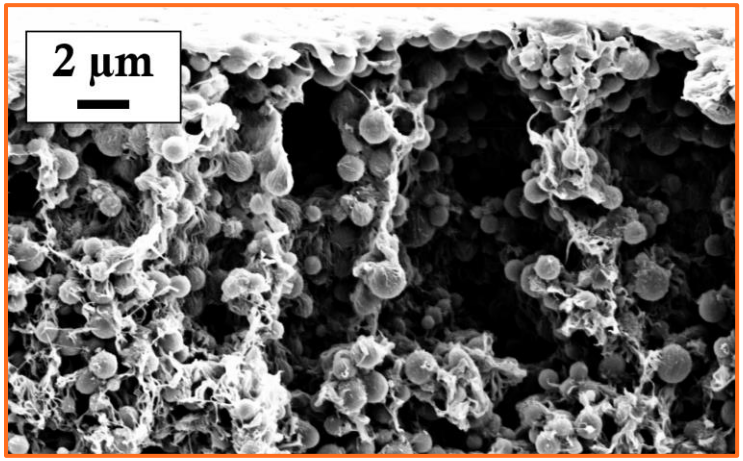


Kotte, et al. *Environ. Sci. Technol*. **2015**, *49*, (16) 9431–9442.

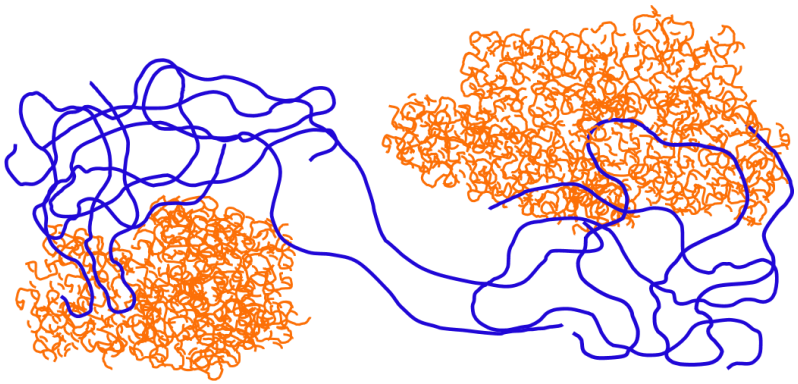
Hwang, et al. *Water Res*. **2015**, *73*, 181–192.

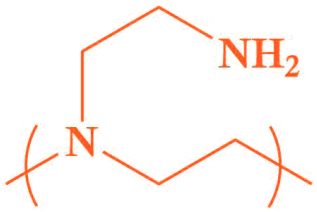


Pure PVDF membrane

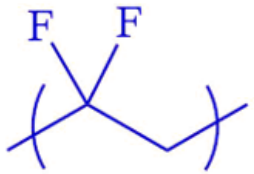


PEI/PVDF mixed matrix membrane





Poly(ethyleneimine)
PEI
600 g/mol

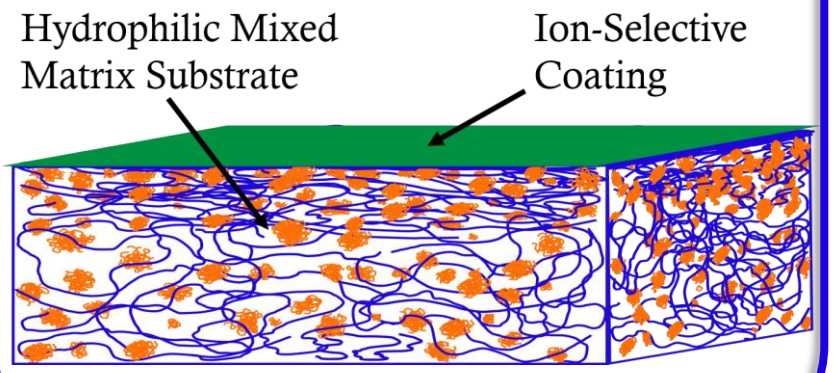


Poly(vinylidene fluoride)
PVDF
400,000 g/mol

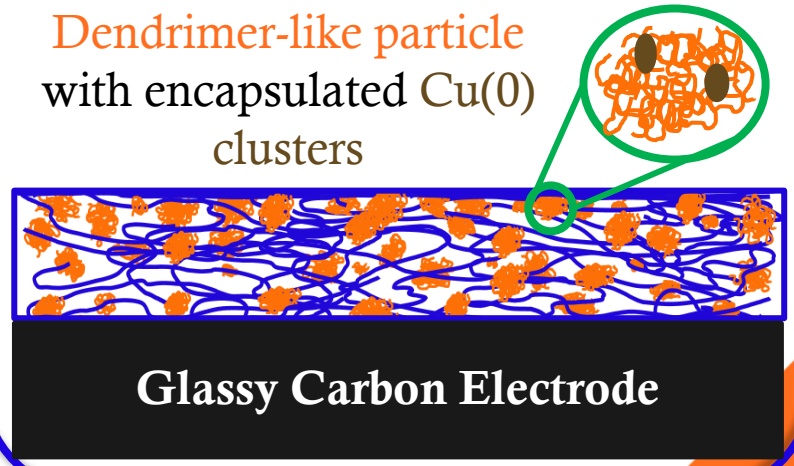
Avenues of study of mixed matrix membranes with *in-situ* generated polymeric particles

Fundamental Study of Structure Development in Mixed Matrix Membranes

Thin Film Composite Membranes for Nanofiltration

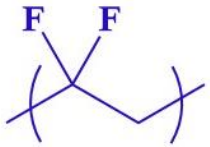


Catalytic Polymer Films for Electrochemical Reduction of CO_2



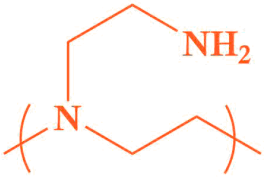
Preparation of mixed matrix membranes

PVDF Dissolved in Good Solvent

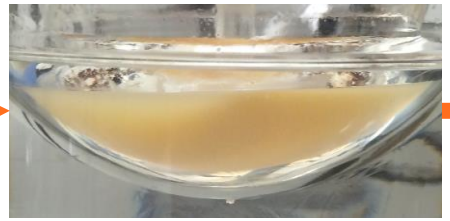


PVDF

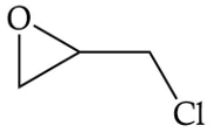
PVDF + PEI



PEI



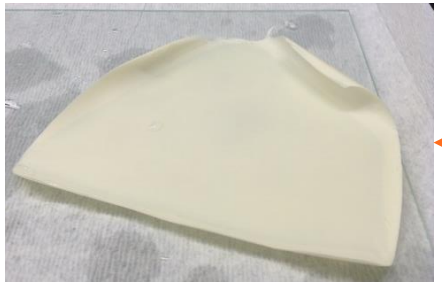
PVDF + PEI + Acid + ECH



Epichlorohydrin **(ECH)**

PVDF + Crosslinked Particles

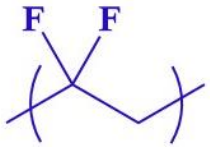
Non-solvent Induced Phase Separation



Cast Membrane

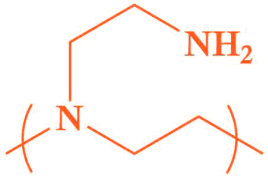
Preparation of mixed matrix membranes

PVDF Dissolved in Good Solvent

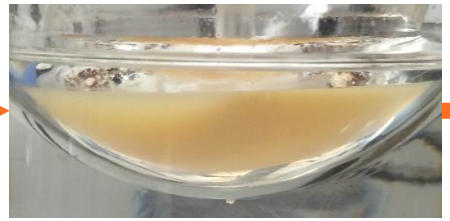


PVDF

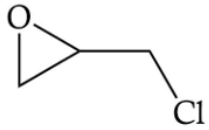
PVDF + PEI



PEI



PVDF + PEI + Acid + ECH



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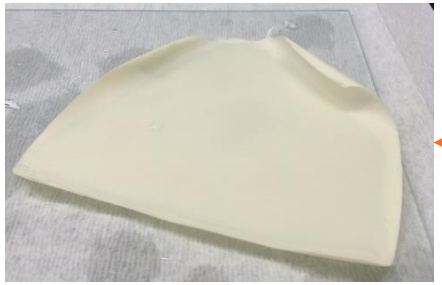
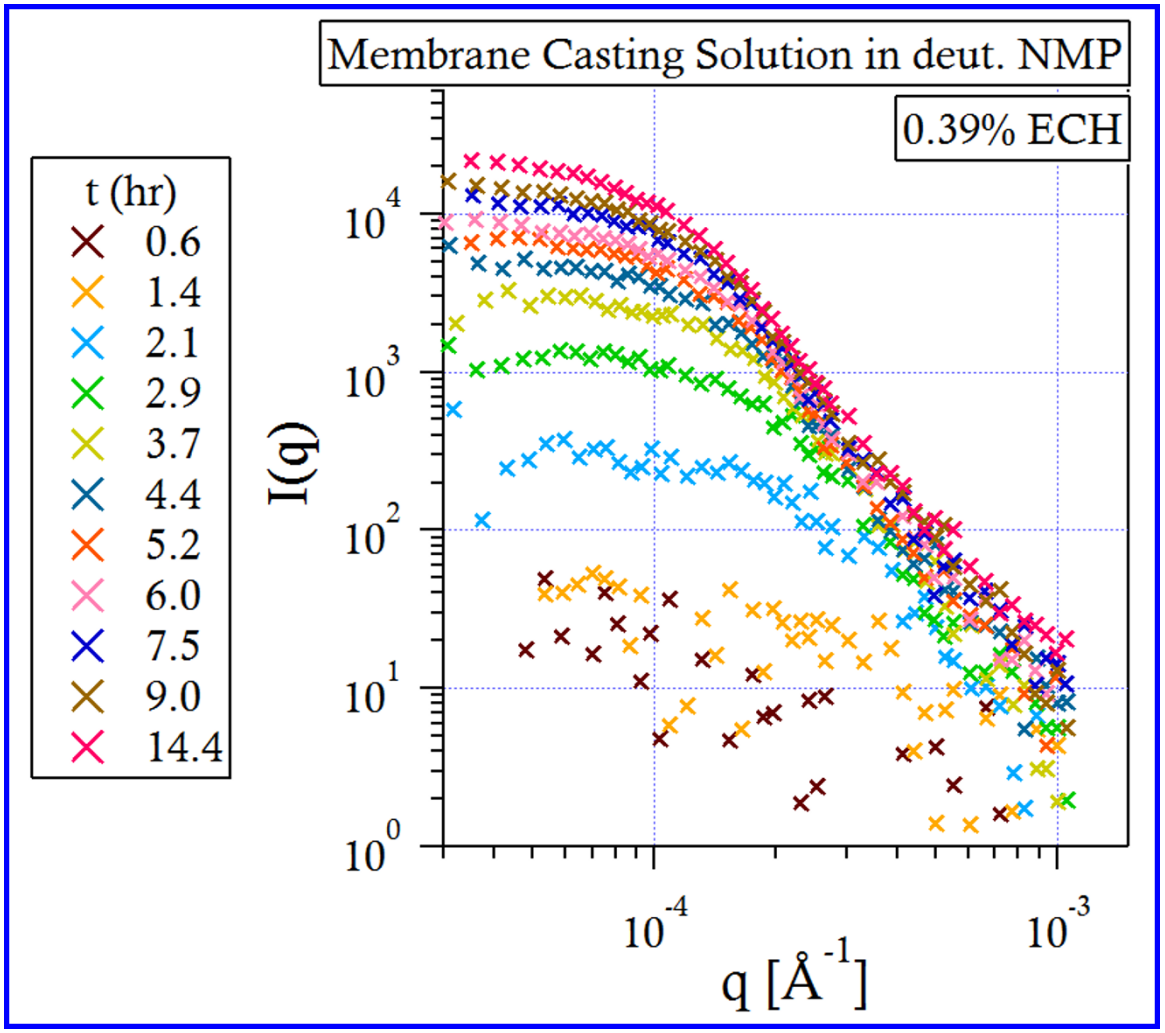


Cast Membrane

The problem demanded a new methodology:
Novel application of Ultra-Small Angle Neutron Scattering (USANS)



- Slowed reaction time by decreasing concentration of ECH
- Decreased acquisition time by an order of magnitude
- Novel way to study structure in membrane casting solutions

Looking Forward

- Isolate structural contributions of each component in the casting solution using fully deuterated amine precursors

- Explore ion-rejecting coatings for NF membranes

- Precipitate and encapsulate copper nanoparticles in dendrimer-like particles of membranes for electrochemical reduction of CO_2

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