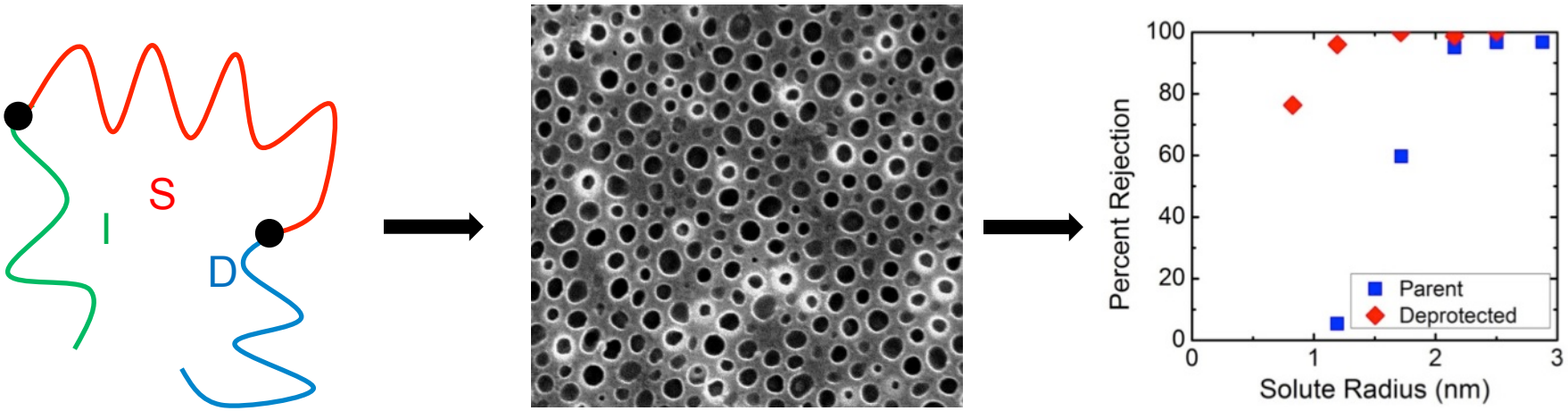
Tunable Nanoporous Membranes with Chemically Tailored Pore Walls from Triblock Terpolymer Templates



Presented by Jacob L. Weidman[1]
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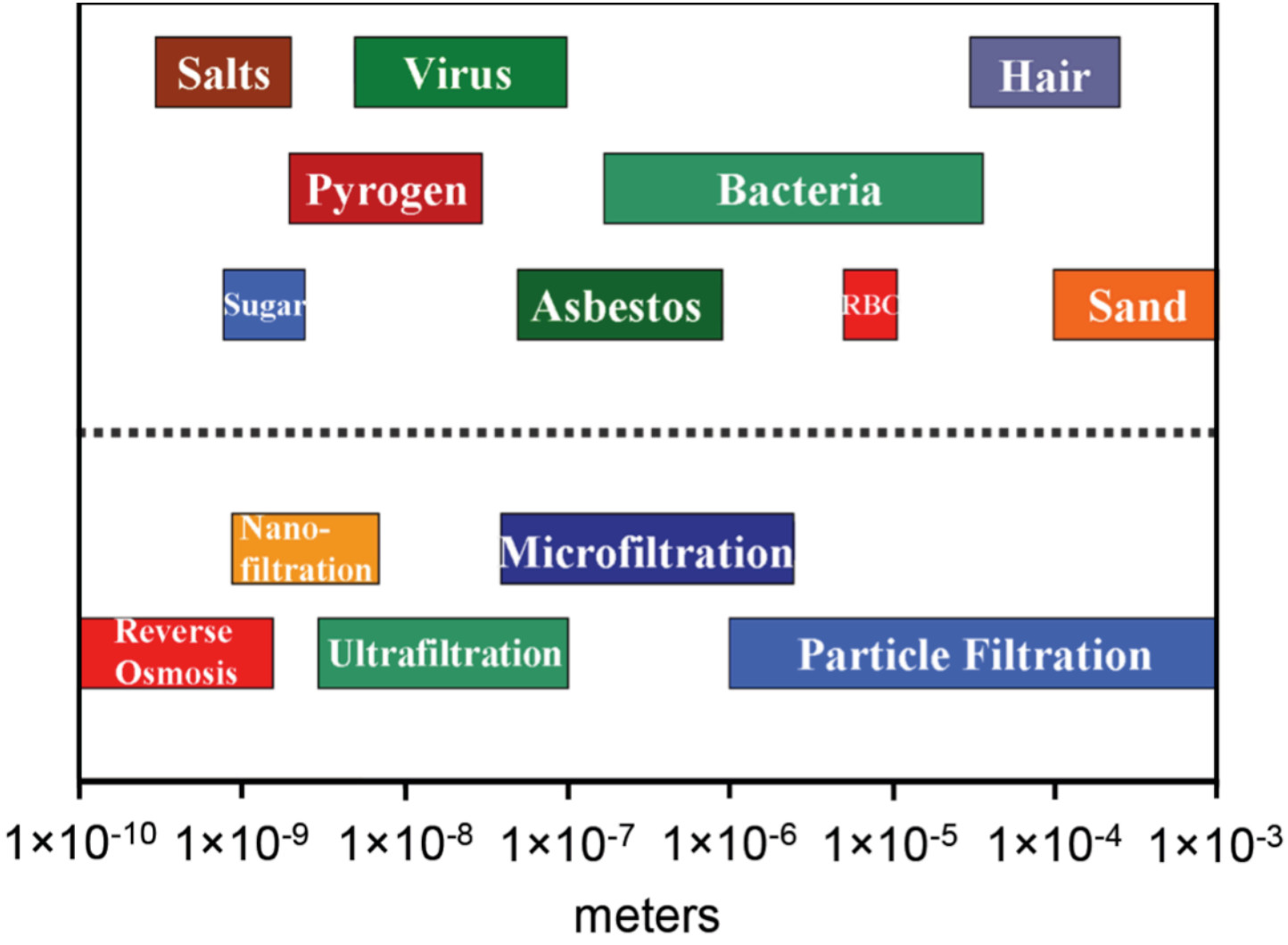
Filtration is Size-Selective

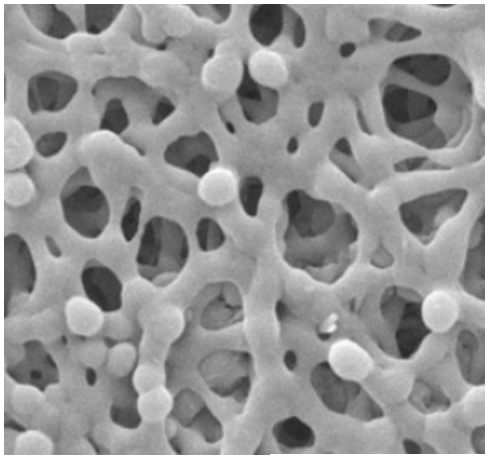


A New Membrane Material

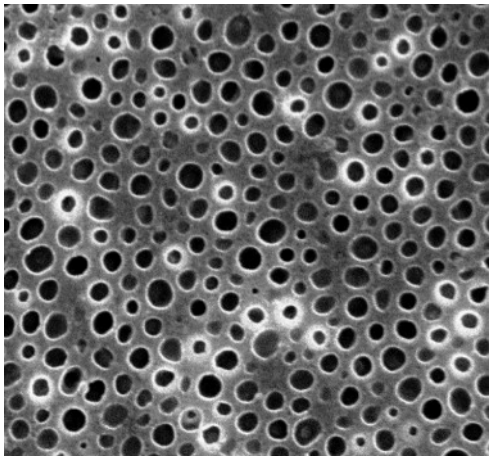
Desired qualities for ultrafiltration membranes:

- High flux
- Good selectivity
- Mechanical integrity
- Low fouling

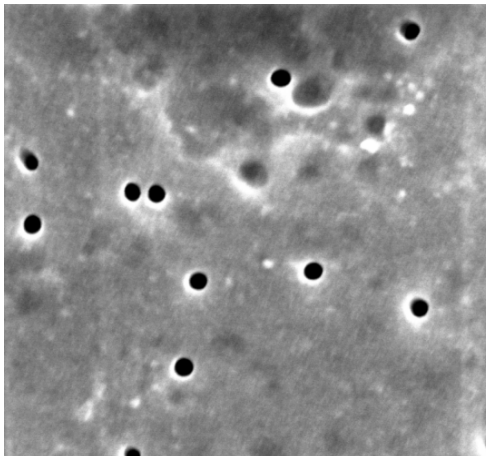
Phase inversion



Self-assembled

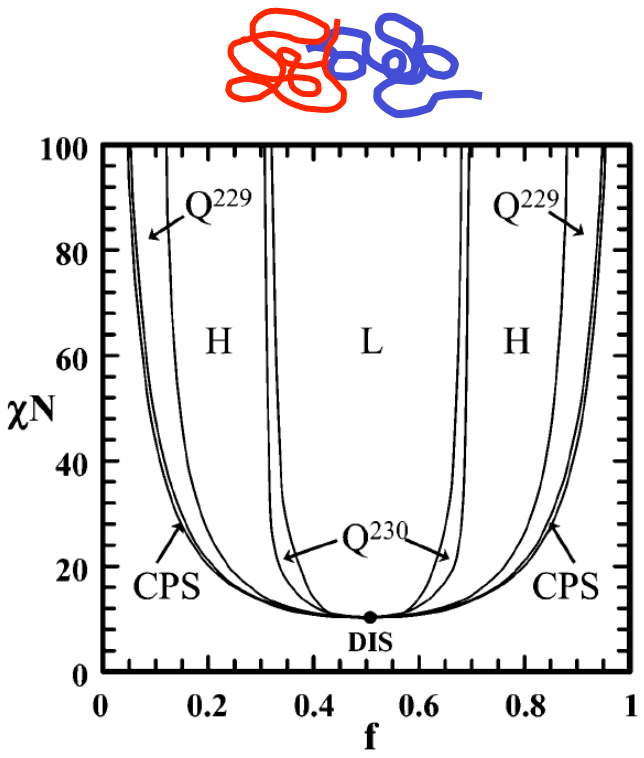


Track-etched



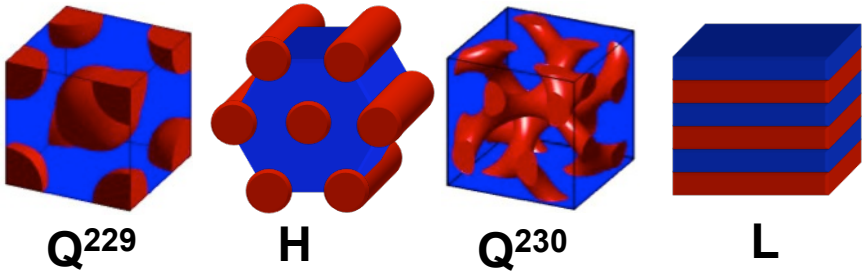
Block Copolymers Self-Assemble

Theoretical Coil-Coil
Diblock Copolymer Phase Diagram



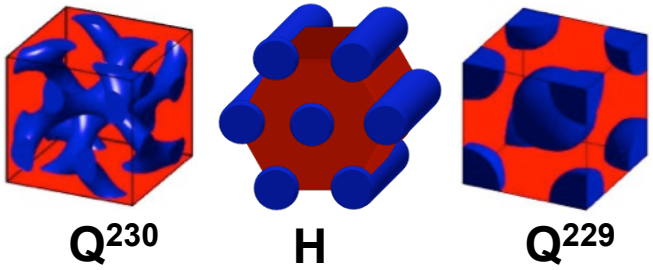
N = number of segments
χ = interaction parameter
f = polymer volume fraction

Red Polymer *MINORITY PHASE*



f_{Red} →

Red Polymer *MAJORITY PHASE*

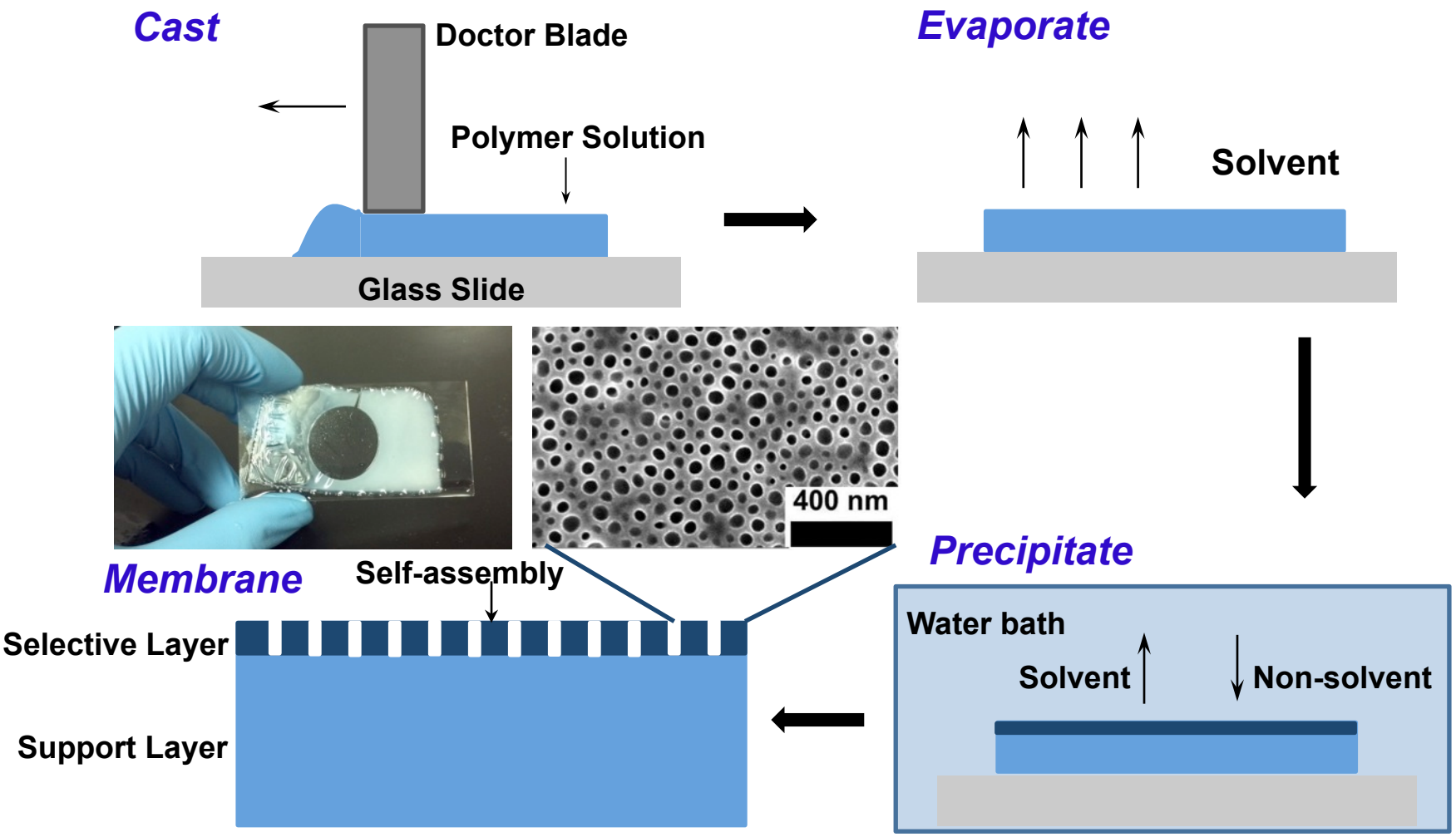


f_{Red} →

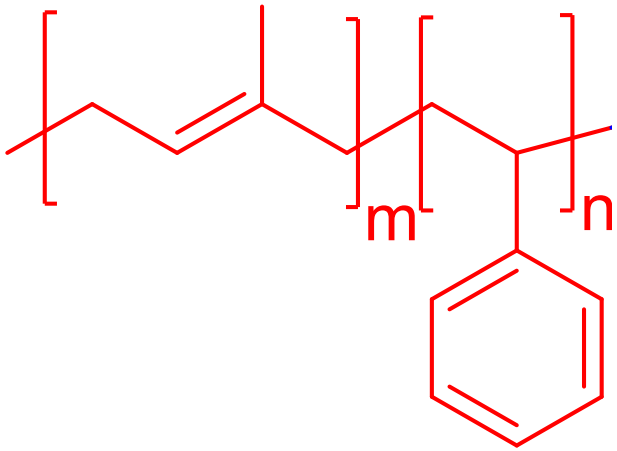
Cochran, E. W. *et al*. *Macromolecules* **2006**, *39*, 2449.

Membrane Cast by SNIPS

SNIPS- Self-assembly and Non-solvent Induced Phase Separation

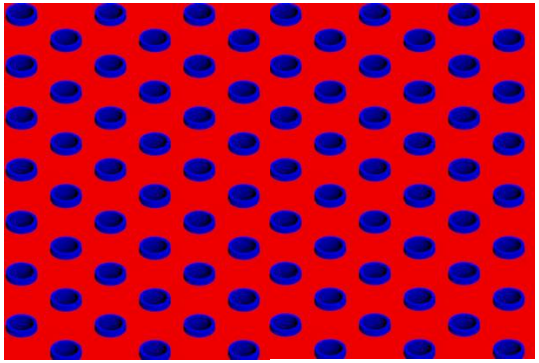


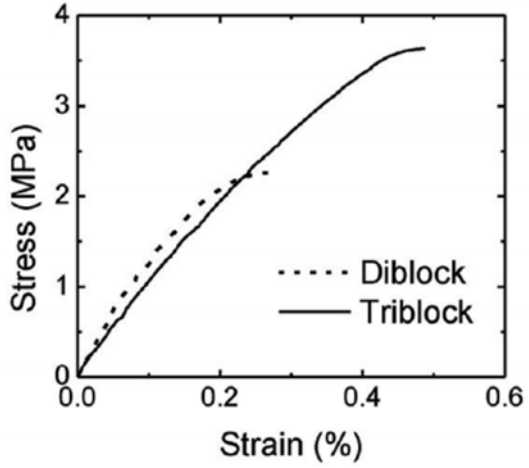
Prior Efforts Limited by Functionality



Cast

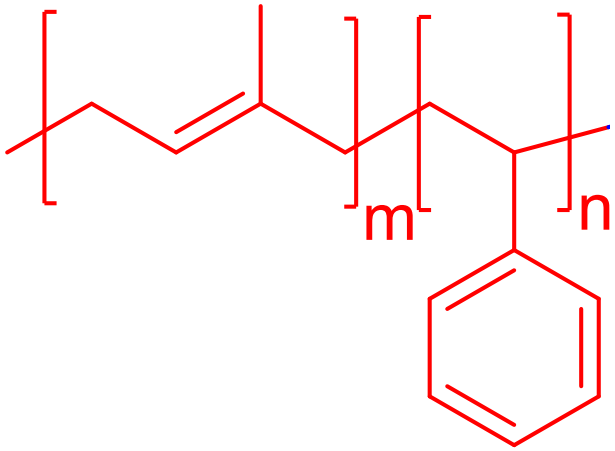
mbrane





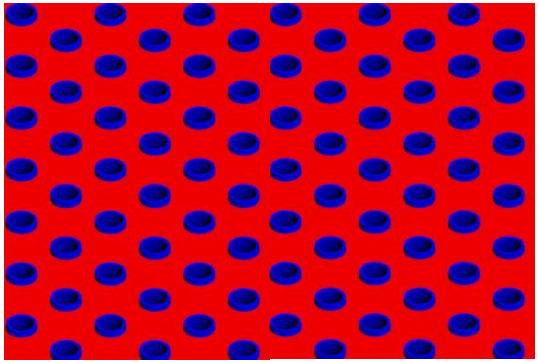
Phillip, W. A. *et. al. Nano Letters*, **2011,** 11, 2892-2900.

Pore Walls Can be Functionalized

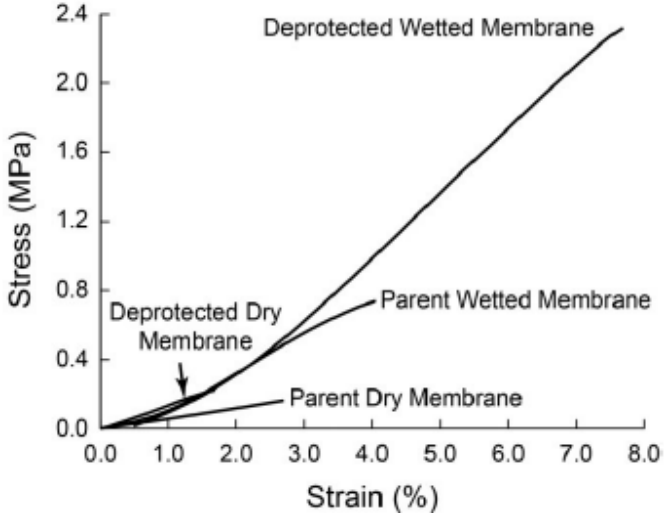


Cast

Membrane

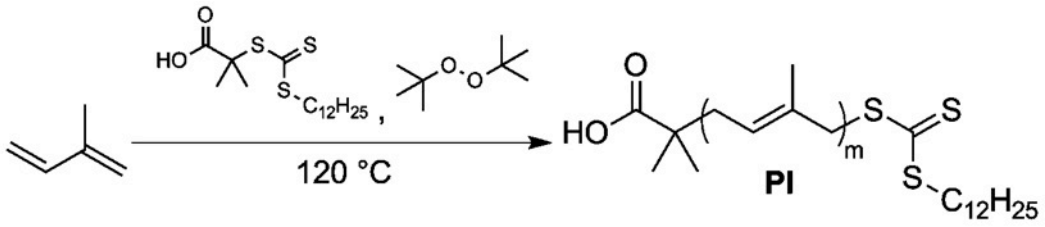


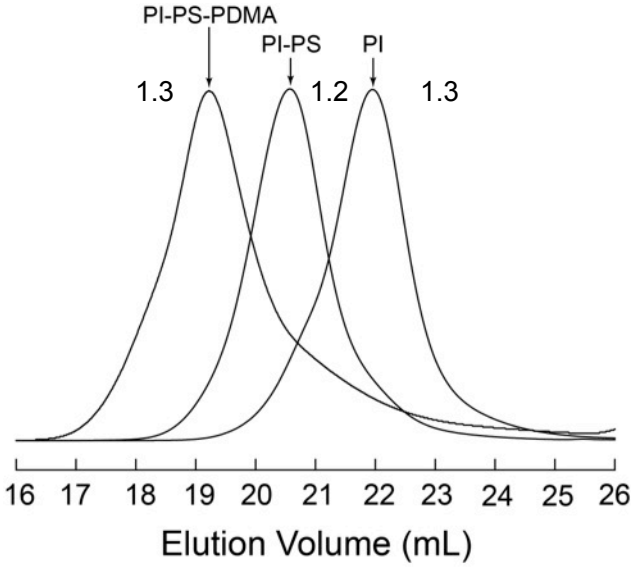
Block	Function
Polyisoprene	Decreases brittleness
Polystyrene	Forms matrix



Triblock Polymerization by RAFT

RAFT- Reversible Addition-Fragmentation chain Transfer



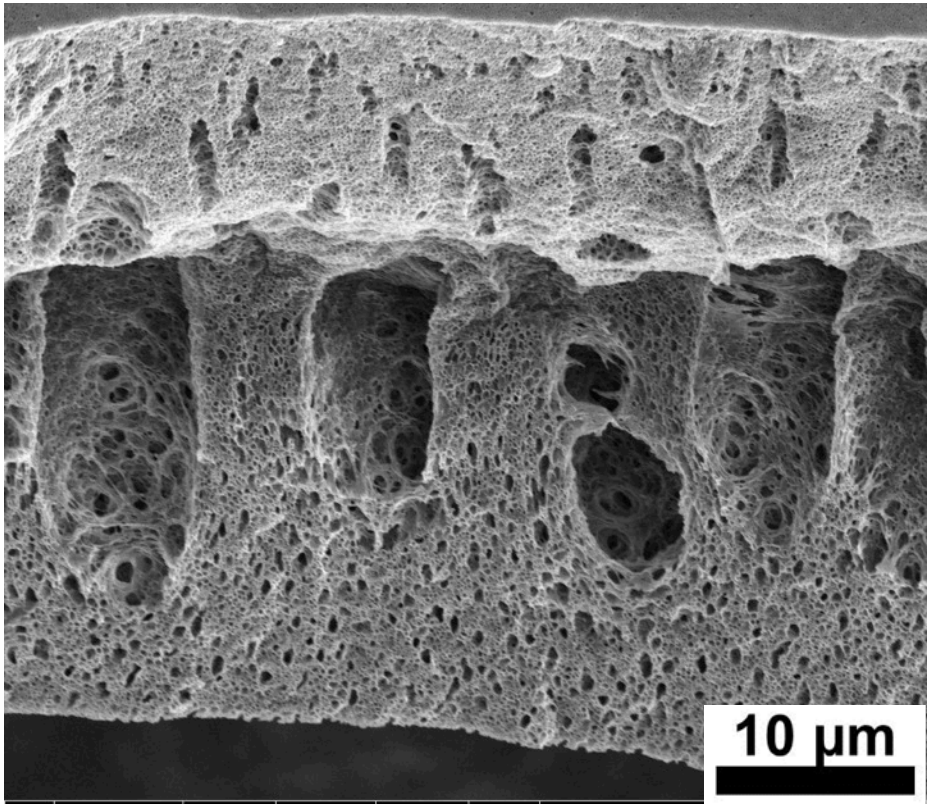


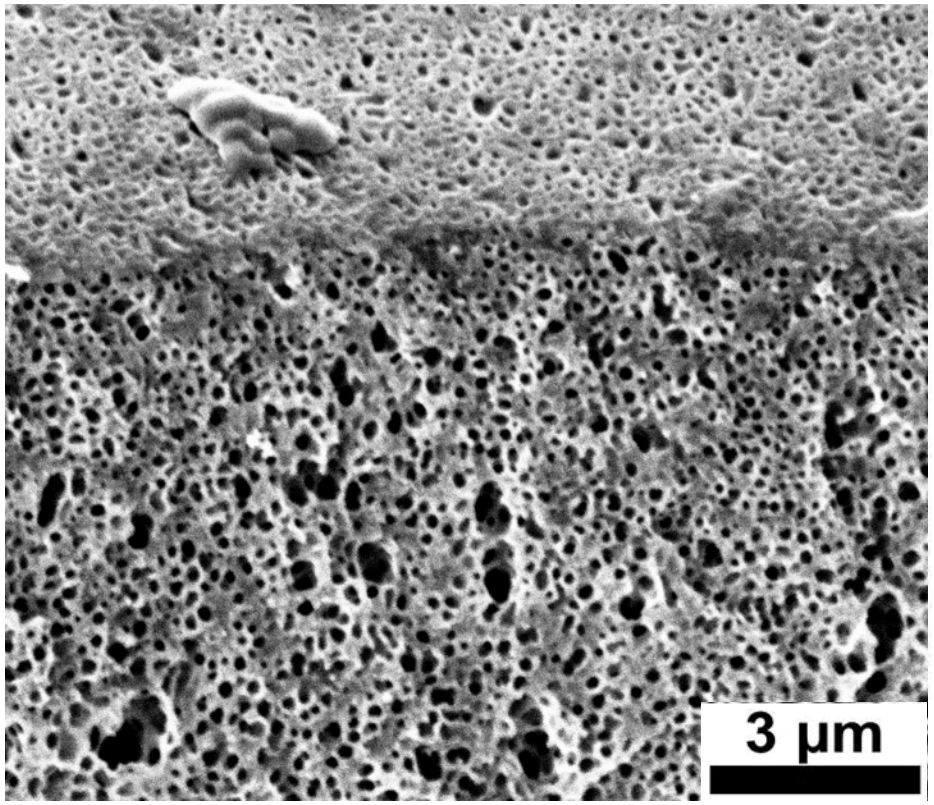
Low dispersity

Metal-free

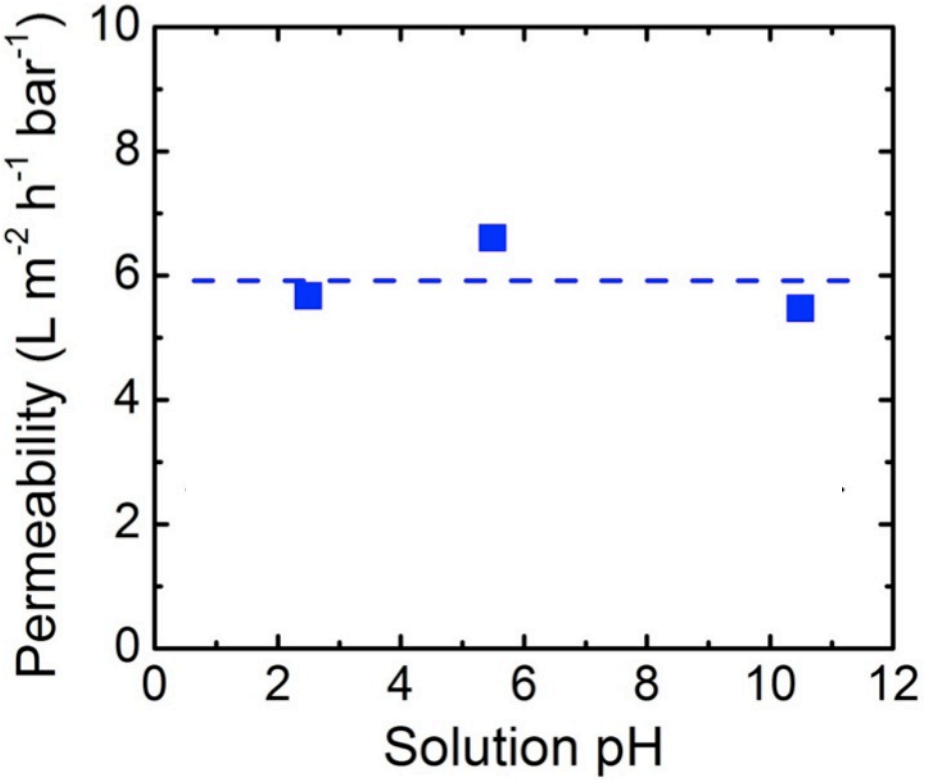
Tolerant of atmospheric conditions

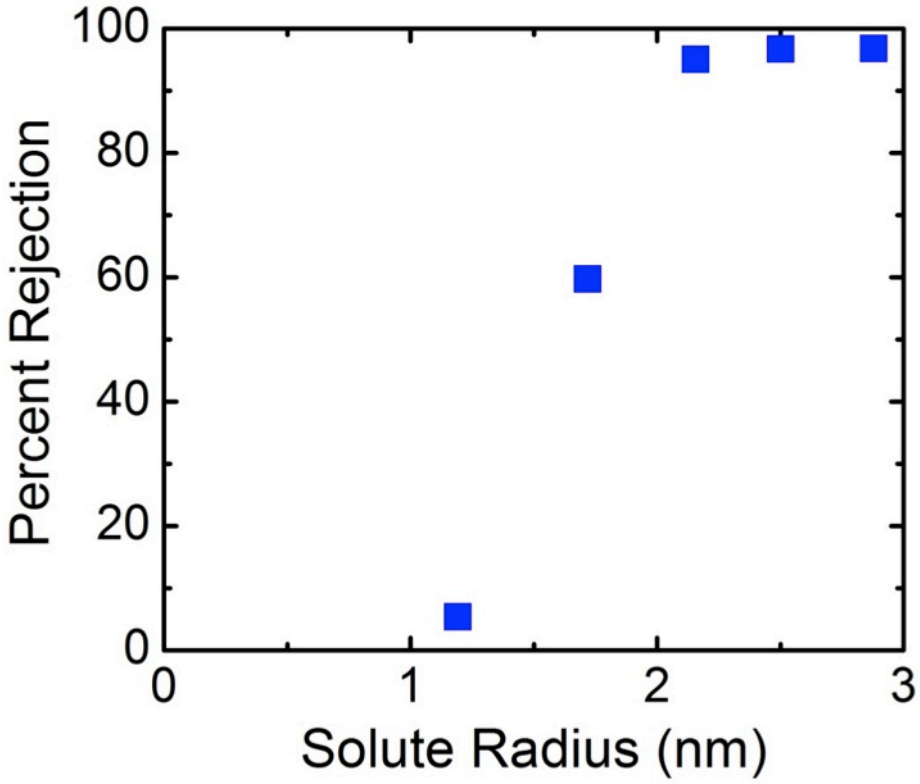
Asymmetric Membrane Produced



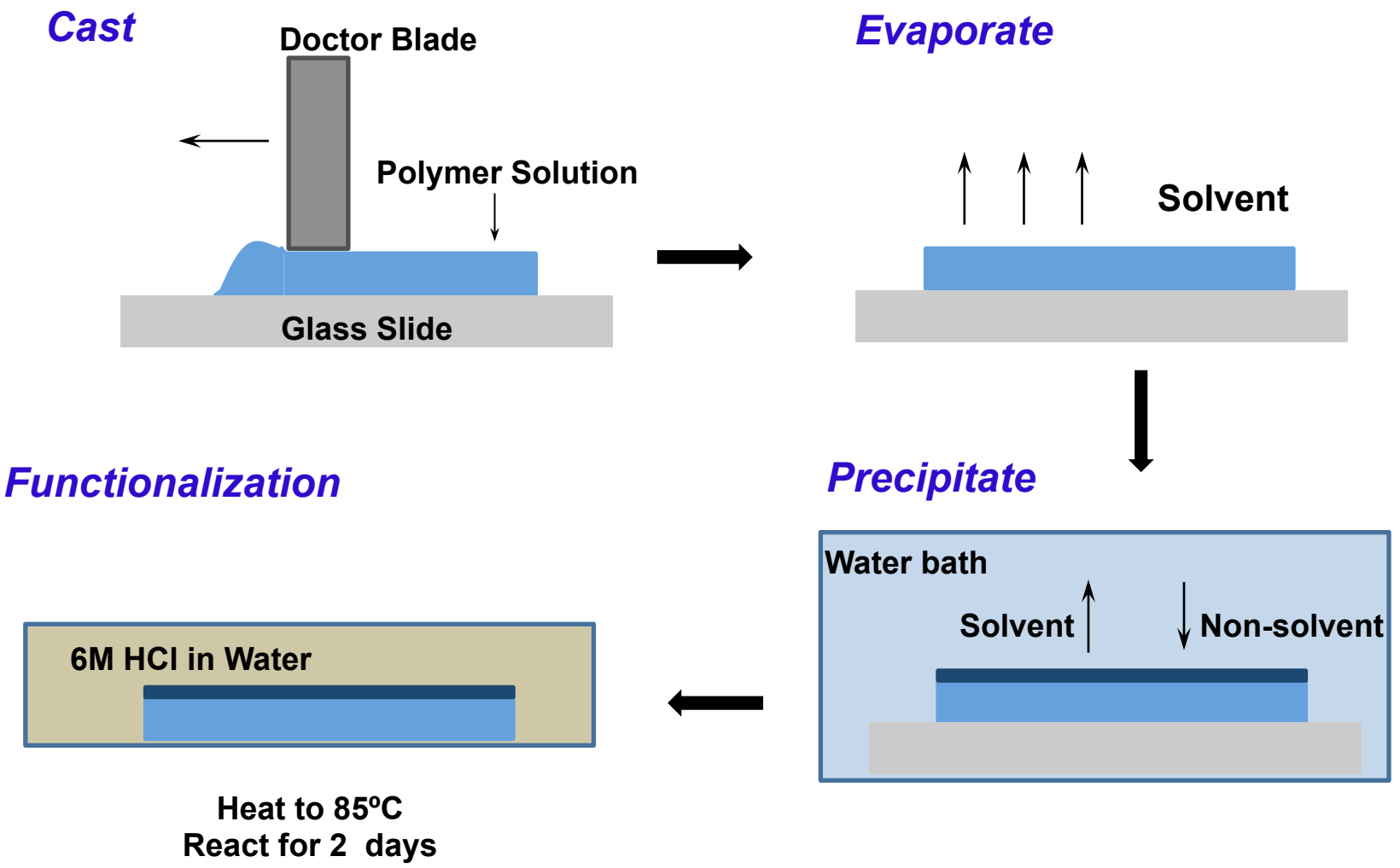


A Permeable and Selective Membrane

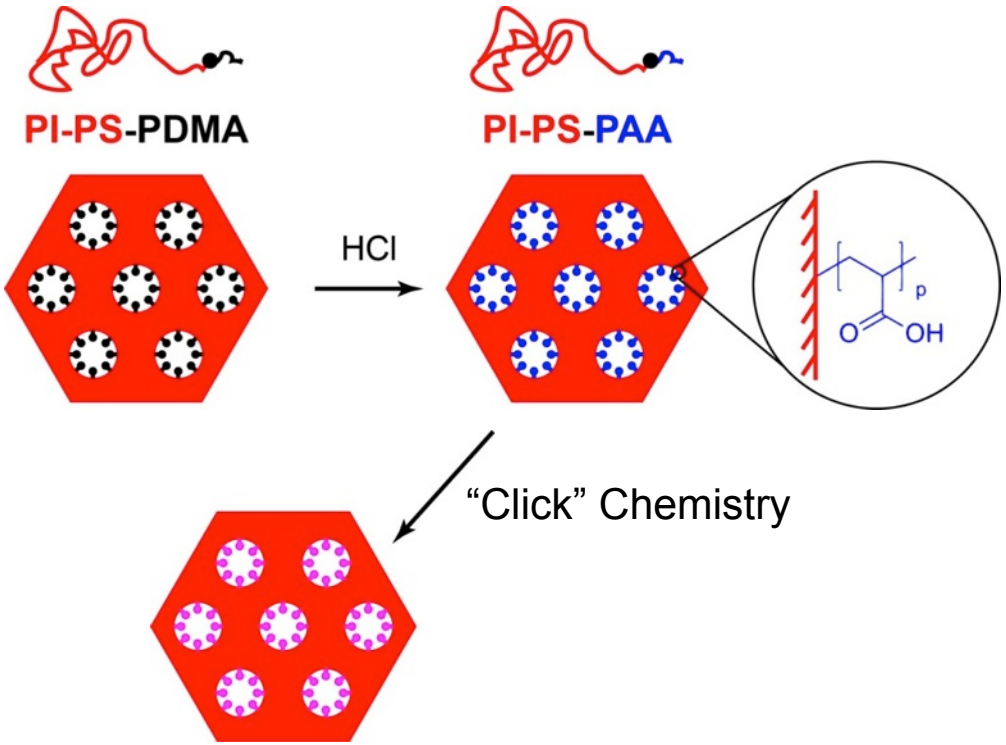




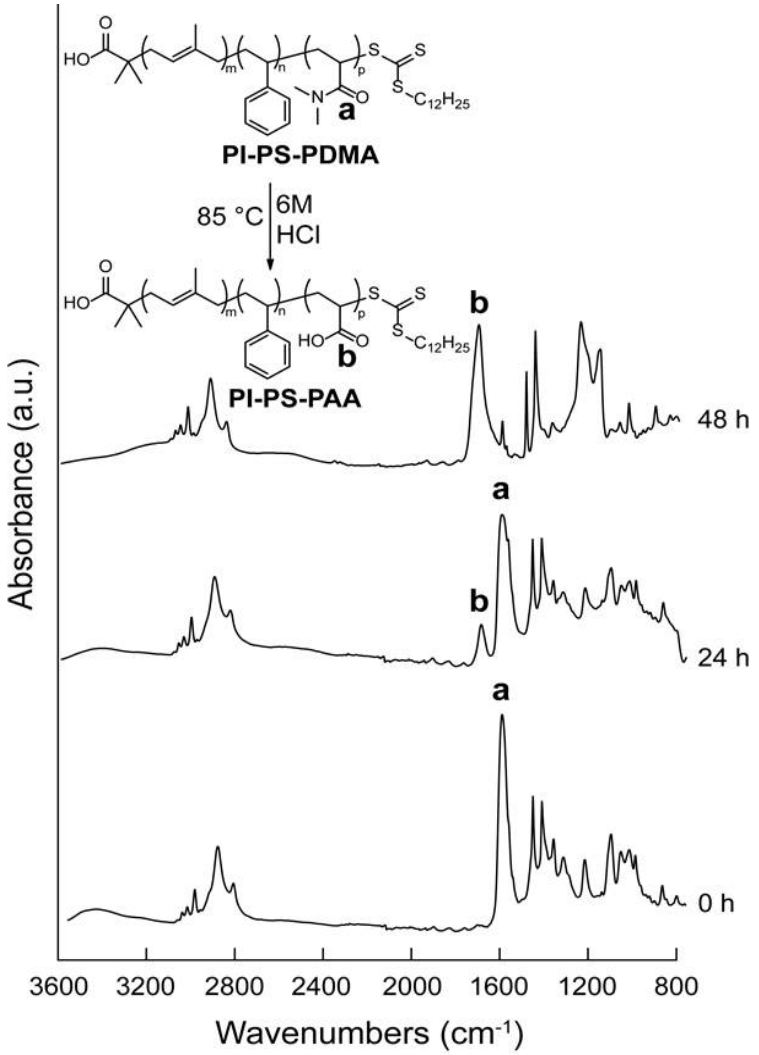
Membrane Functionalization



Functionalization Alters Pore Chemistry

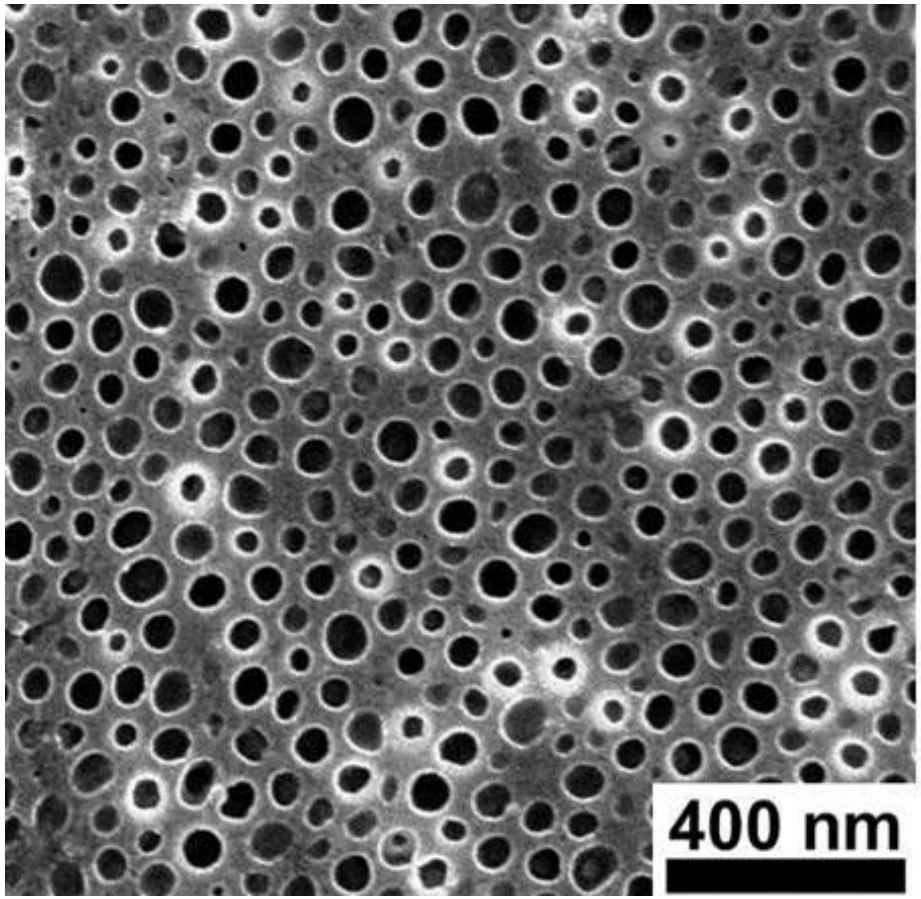


Pore walls can be reacted to a variety of functional groups (pink dots).

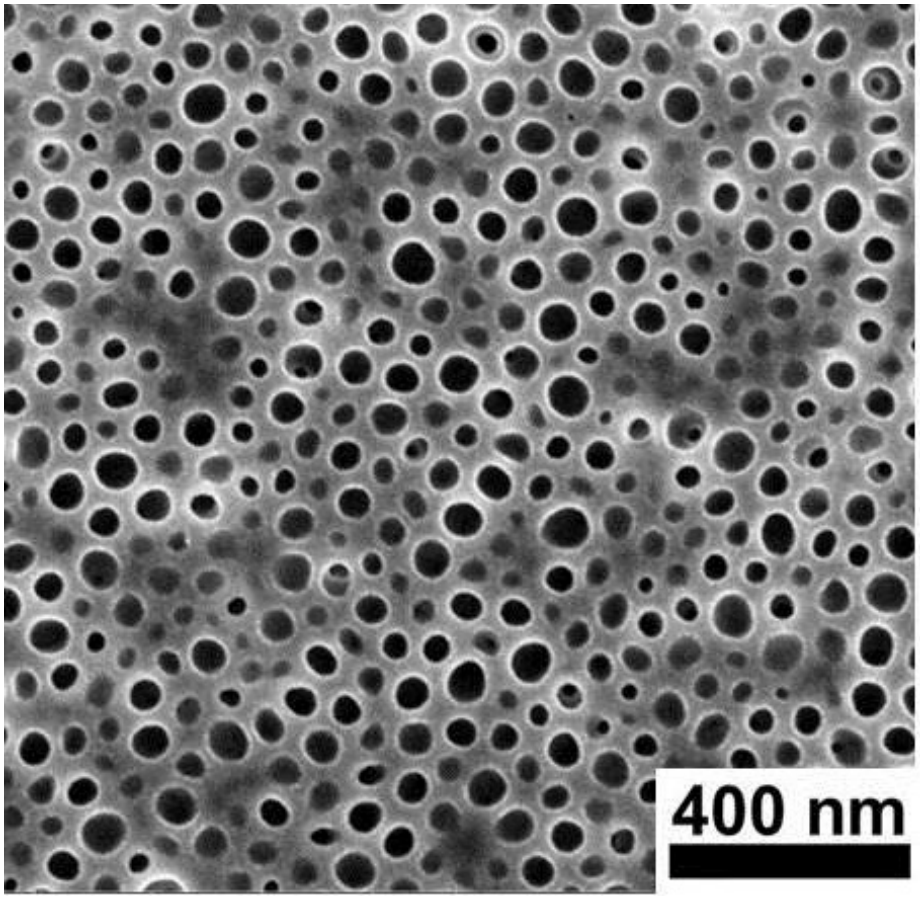


Porous Structure Retained

Parent

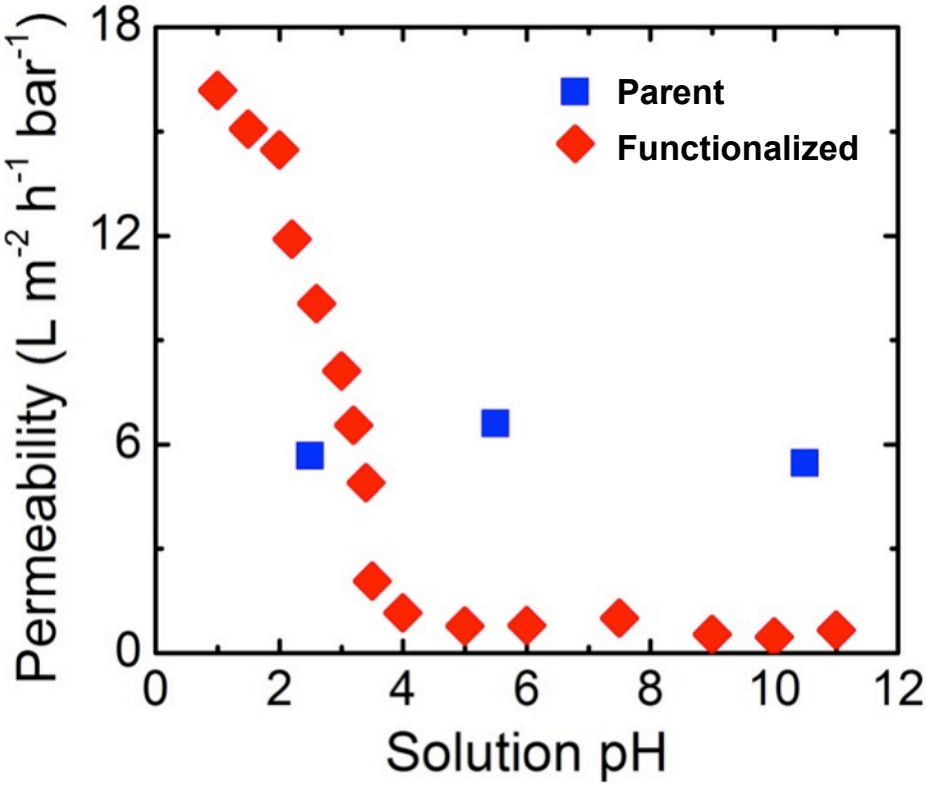


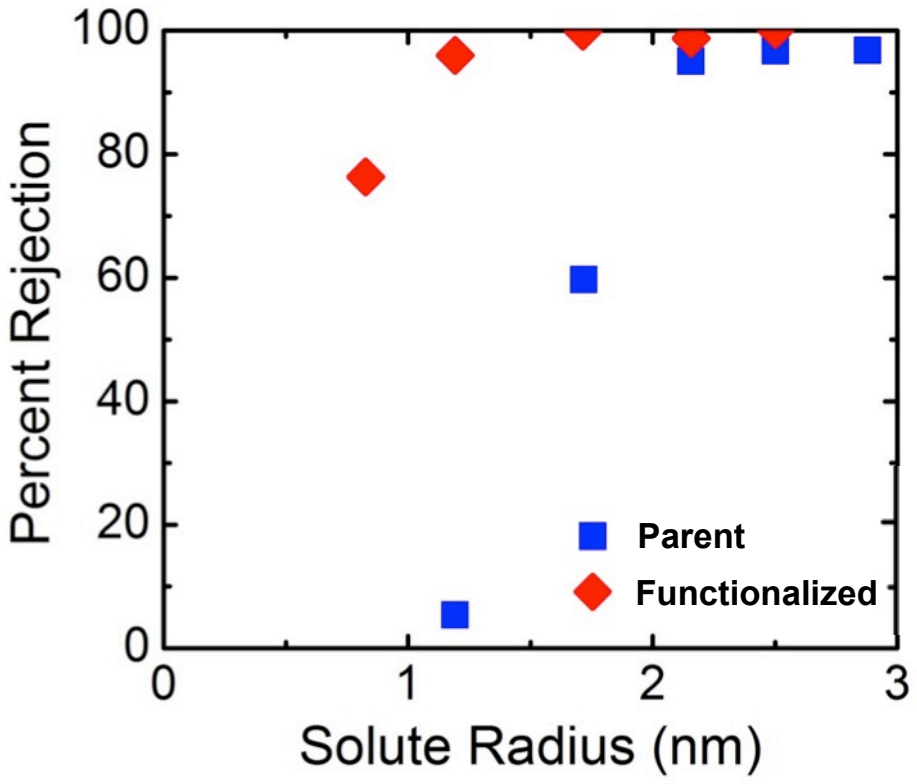
Functionalized



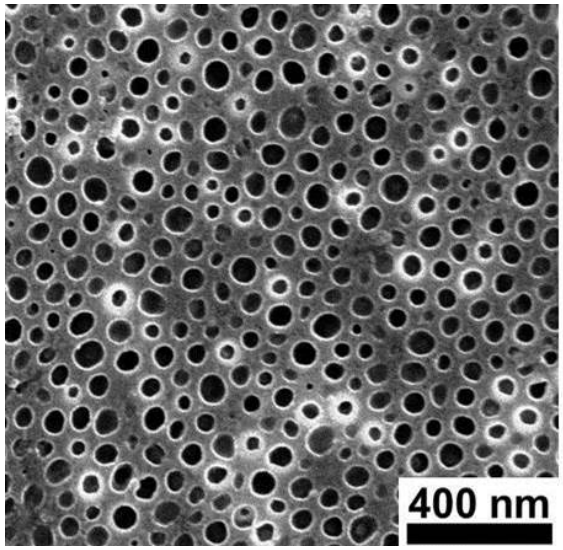
Less than 4% deviation in average pore size and porosity

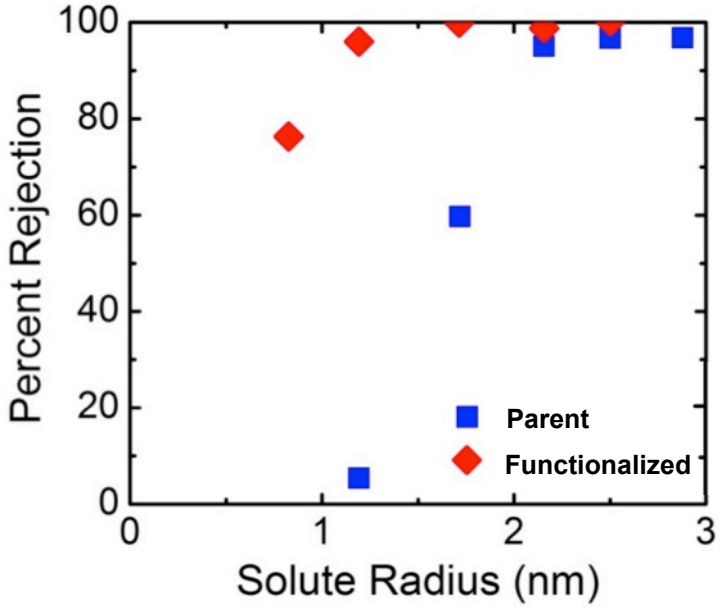
A Selective pH-responsive Membrane





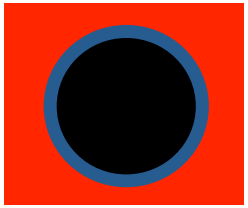
How Pore Wall Groups Affect Pore Size

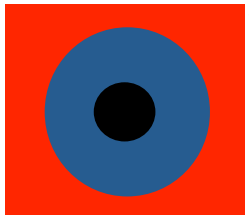




Dry state (SEM)

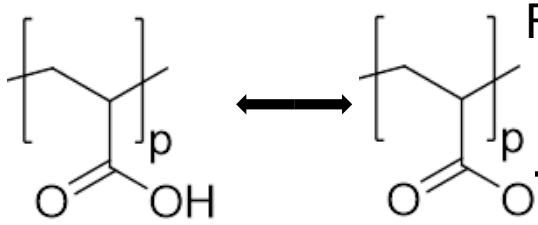
Average- 52 nm





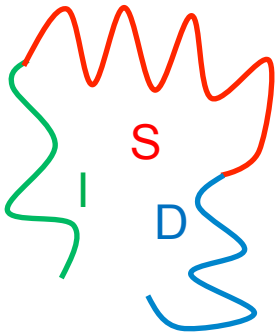
Wet State (MWCO)
Parent Membrane
Estimated- 8.1 nm

- AFM to compare wet/dry pore sizes
- New functional to line pore walls
- Transport tests for targeted applications



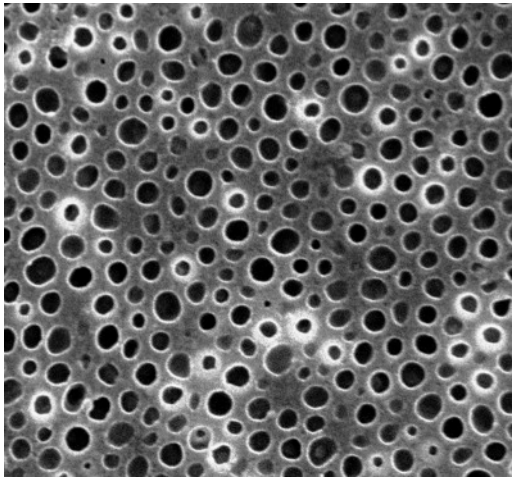
Functionalized
Estimated
-2.6 nm

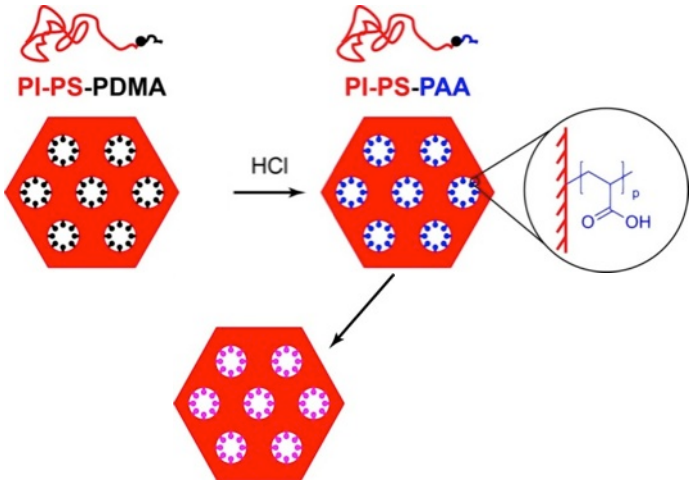
Conclusions



Controlled radical polymerization allows for a scalable production method of terpolymer with tunable block lengths and low dispersity.

This material produces robust selective membranes with a high density of monodisperse pores in the self-assembled selective layer.





Pore walls have been successfully deprotected to a functionalizable polyacrylic acid group, lending itself to a variety of applications by simple chemical conversion.

Acknowledgements

Special thanks to:

INDIANACTSI
Clinical and Translational Sciences Institute

Professor Bryan W. Boudouris

Ryan A. Mulvenna

Professor William A. Phillip

John Pople

As well as:

- Center for Environmental Science and Technology (CEST)
- Notre Dame Integrated Imaging Facility (NDIIF)

THANK YOU!!