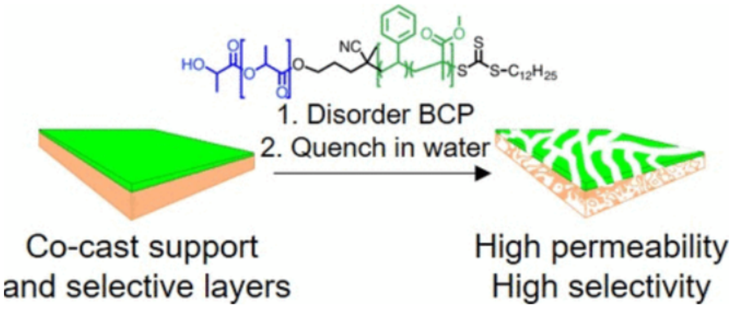
High performing ultrafiltration membranes with high selectivity and permeability (2020-370)

A method to fabricate high performance filtration membranes at industrial scale.

Technology No. 2020-370



IP Status: Provisional Patent Application Filed; **Application #:** 63/072,400

Applications

Filtration Membranes for

- water treatment
- bioprocessing, pharmaceutical manufacturing
- food and beverage industries.

Key Benefits & Differentiators

- **Commercially compatible** method of fabrication
- **Scalable fabrication steps** such as thermal, solvent processing to disorder the selective layer

- **Tailorable** process and material choice based on target application. Process compatible with an array of homopolymers and block copolymers.
- **High selectivity** of membrane enabled by uniform pore size

High performing ultrafiltration membranes with high

The global membrane filtration market is estimated to be valued at USD 13.5 billion in 2019 and is projected to reach USD 19.6 billion by 2025, at a CAGR of 6.4% from 2018 to 2025. High performing ultrafiltration membranes require both high water permeability and high size-selectivity, with important applications in water treatment, biopharmaceutical manufacturing, and the food and beverage industries. Currently, commercial membranes are typically prepared by the process of Non-solvent Induced Phase Separation (NIPS), resulting in membranes with a plurality of continuous pores for high water permeability. However, NIPS membranes have a broad pore size distribution that limits their size-selectivity and consequently their utility for precise separations.

Prof. Hillmyer’s group at the University of Minnesota have developed a scalable method for fabricating block copolymer membranes with both high permeability and high selectivity while minimizing processing and materials costs. By co-casting a homopolymer support layer and a block polymer selective layer into a composite membrane, the high permeability of phase inversion membranes has been combined with the high size-selectivity self-assembled nanostructures of block polymer. The co-casting technique employed here allows for the continuous fabrication of composite membranes with a thin block polymer selective layer and eliminates the need for alignment processes. Additionally, this method is compatible with existing membrane fabrication processes and minimizes the consumption of expensive block polymers. The block polymer membrane fabricated using this method has a composite architecture, contains uniform and co-continuous selective pores, and has high mechanical robustness.

Co-casting of block copolymers and homopolymers

Self-assembled block polymers represent an attractive alternative for membrane preparation due to their uniformly-sized nanoscale domains. Traditionally, ordered block polymer morphologies have been investigated for membrane fabrication, but these morphologies often require the use of challenging and expensive processing techniques to obtain the continuous domains necessary for high water permeability. Furthermore, casting block polymer solutions into thin films suitable for membrane applications presents other challenges related to coating a dilute polymer solution onto a porous substrate. Alternative strategies for block polymer membrane fabrication eliminate the need for a porous substrate by casting free-standing films, but these methods require large quantities of expensive block polymer and often result in undesirably low permeabilities. The method described here - co-casting of block copolymer and homopolymer into composite ultrafiltration membranes - represents a novel technique for obtaining ultrafiltration membranes with commercially desirable properties in a scalable process.

Phase of Development

TRL: 3

Proof-of-concept. The block polymers have been synthesized and their disordered and co-continuous morphology has been confirmed. The co-casting strategy has been demonstrated and the high water permeability and high size-selectivity of these membranes has been verified. Commercialization of this technology will require further fundamental research into the nature of the disordered state, engineering approaches to kinetically trap the disordered state, and process adoption for fabrication in industrial scale.

Desired Partnerships

This technology is now available for:

- License
- Sponsored research
- Co-development

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Researchers

- [Marc A. Hillmyer, PhD](#) Professor, Department of Chemistry, Director, Center for Sustainable Polymers.

References

Hampu, Nicholas, Jay R. Werber, and Marc A. Hillmyer, https://doi.org/10.1021/acsami.0c13726, ACS Applied Materials & Interfaces, 12.40 (2020): 45351-45362.

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