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August 8, 2025,

Dear Profs. Rong Wang and Jerry Lin, Editors-in-Chief:

We are pleased to submit our article entitled “Developing and Validating a High-Throughput Robotic System for the Accelerated Development of Porous Membranes” for consideration in *Journal of Membrane Science.*

The central challenge in membrane fabrication via nonsolvent-induced phase separation (NIPS) is the high-dimensional design space with many interacting parameters, which makes systematic, reproducible exploration difficult, and renders NIPS an “art more than a science.” We present a fully automated platform that integrates solution preparation, blade casting, controlled immersion, and rapid mechanical readout via compression testing. The system provides precise control of fabrication parameters (for example, polymer concentration and ambient humidity) and delivers a reproducible workflow from formulation to quantitative readout in under an hour per sample. It is built for efficient exploration of the NIPS design space and seamless integration with self-driving laboratory workflows with machine learning.

Within this framework, compression testing serves as a sensitive, scalable proxy for membrane internal structure. Automated analysis of stress-strain curves extracts descriptors such as stiffness (elastic modulus), a porosity-correlated metric (pore fraction), and measures of intra-sample uniformity. We validated the platform using polysulfone in the green solvent PolarClean® with water as the nonsolvent, with stress-strain curves serving as the quantitative measure for reproducibility. As a proof of concept, we then used the system to explore this polymer/solvent/non-solvent system, reproducing expected parameter-property relationships: increasing polymer concentration produces stiffer, more uniform, sponge-like morphologies, while ambient humidity modulates demixing kinetics and pore architecture. We also note that dry-nitrogen exposure during casting can yield finger-like macrovoids together with unexpectedly high stiffness and strength, a finding that suggests micro-mechanical behavior meriting further study.

To our knowledge, this is the first high-throughput system ever developed for NIPS, and is the first step in our work towards a “self-driving lab” for NIPS. In our next steps, we will use the presented system for automated, closed-loop membrane R&D in which the system iteratively makes a membrane, tests the membrane, and then decides on the conditions for the next membrane synthesis. We believe these advances will be of immediate utility to researchers seeking scalable, reproducible membrane fabrication and rapid structure-property mapping, and they open a pathway toward autonomous optimization in complex fabrication spaces.

We respectfully suggest David Latulippe (McMaster), William Phillip (Notre Dame), and Yifu Ding (Colorado) as potential reviewers for this manuscript.

Regards,

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