RESEARCH BRIEF
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NAWI National Alliance for Water Innovation

Additive Manufacturing for Customized Membranes

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Challenge

Reverse osmosis membranes are manufactured using a process termed, conventional interfacial polymerization (IP), which relies on in-situ formation of the polyamide at the interface of two immiscible phases. While a number of membrane chemistries can be manufactured in this way, there are inherent limitations, including the inability to adjust chemistry "on-the-fly" during the manufacturing process or to create layered or gradient structures across a membrane's depth (i.e. "gutter layers", mixed matrix membranes). Furthermore, conventional IP cannot does not allow the chemistry to be decoupled from the kinetics of membrane formation, meaning that simply changing the monomer chemistry may result in unforeseen or undesired membrane properties.

Research Approach

In 2018, PI McCutcheon invented a new additive manufacturing method that creates ultra-thin film polyamide membranes with tunable properties. This method used a process that has been described as electrospray printing (Figure 1), which deposits films that are exceedingly thin but tunable in their thickness and roughness. More importantly, the method forms films that are defect free, which is a key property for manufacturing any desalination membrane.

The objectives of this project are to using this novel additive manufacturing approach to develop desalination membranes and:

1. Identify and address manufacturing limitations that prevent the manufacturing of tailored desalination membranes.
2. Establish parameters in the manufacturing process, which will confer control over desired membrane properties.
3. Ensure quality control (at a molecular level) during manufacturing.
4. Demonstrate an economically viable online metrics for assessing consistency of thickness.
5. Assess the costs and benefits associated with manufacturing membranes tailored to the specific needs of individual treatment systems.

Impact

Electrospray printing will enable new degrees of freedom in membrane design and allow manufacturers to tailor membrane properties to specific applications and water chemistries. The development of a new membrane manufacturing technique could change the way membranes are manufactured, how treatment systems are designed, and has the potential to dramatically reduced chemical usage during manufacturing, ultimately leading to potentially lower capital cost.

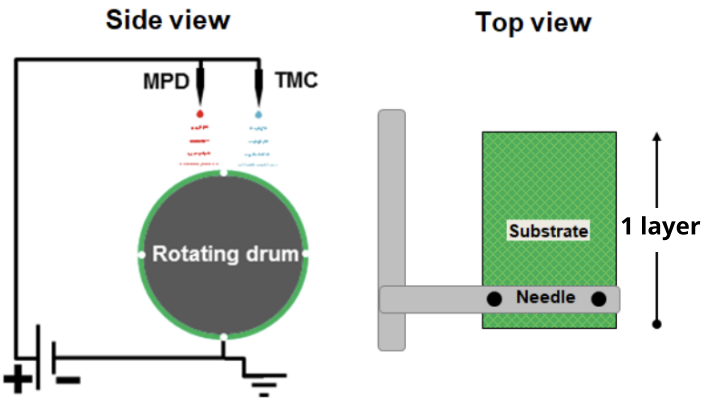

Figure 1. Illustration of the lab-scale electrospray process with a single drum. Monomers are deposited by a needle, sequentially, onto a substrate that is attached to the rotating drum where they react to form aromatic polyamide. The lab-scale system can make up to 1 square foot of material and is representative of a continuous process and can be expanded.

RESEARCH PARTNERS

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