Layer-by-Layer Synthesis of Polyamide Thin Film Composite Membranes for Desalination Applications

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By

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The Dissertation Committee for Wendy-Angela Agata Certifies that this is the Approved Version of the Following Dissertation:

Layer-by-Layer Synthesis of Polyamide Thin Film Composite Membranes for Desalination Applications

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Dedication

To everyone who have supported me on my journey pursuing a Ph.D.– this is for you.

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Throughout this journey towards a PhD I have had considerable support. There have been many triumphs, as well as downfalls during my pursuit of this degree and at times I felt as though I could not continue. However, it is through the tremendous support of the people below that I am at the position where I am able to not only sow the seeds of my labor but profusely thank all the wonderful people who have been instrumental in my success.

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Abstract

Understanding how polymer backbone structure effects water and salt transport is an essential part of designing efficient desalination membranes. Current commercialized ion exchange membranes contribute to the high cost of desalination process through both expensive synthesis processes and low energy efficiencies. Through the addition of selective fillers or fixed charge groups to well understood polyamide (PA)-based thin-film composite reverse osmosis membranes, we aim to take advantage of their low resistance while introducing Donnan exclusion or size sieving to facilitate the selective removal of impurities. We aim to shift "layer-by-layer" deposition of m-phenylenediamine and trimesoyl chloride onto microporous supports for composite membrane formation by priming supports with polyvinyl alcohol to seal defects formed in the PA layer as well as protect these polysulfone-based supports from continued organic solvent exposure. The application of layer-by-layer synthesis of selective polyamide layers will then be assessed for extension to both the incorporation of fixed charge groups, via the addition of a sulfonated co- monomer, as well nanofillers, via the addition of UiO66-NH_2, a metal organic framework. Water and solute transport information for the various composite membranes studied will be analyzed using a resistance in series model to elucidate key structure/property relationships important for further optimization of the polyamide layer for more efficient desalination.

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