Desalination of brackish water through low temperature MLD activated membranes

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As populations have increased in areas with limited fresh water supplies, desalination has necessarily filled the gap for fresh water for agricultural and domestic use. Most desalination is done by reverse osmosis, which removes most minerals from the water. While remineralizing reverse osmosis water is possible, it is costly. As a result, desalination methods which do not remove beneficial minerals are attractive.

Molecular layer deposition (MLD) is a thin film deposition technique that has gained attention in recent years because of its ability to deposit polymer thin films at low deposition temperatures. A key advantage of MLD is its ability to coat high aspect ratio, high surface area substrates with a flexible, conformal, and pin hole free thin film. Dr. Eran Edri and Dr. Oded Nir from Ben-Gurion University of the Negev applied atomic layer deposition (ALD) and MLD to a new and increasingly important application: surface modification of membranes used for water desalination.

Dr. Edri and Dr. Nir present another solution by utilizing MLD to make ion selective nanofiltration (NF) membranes and monovalent selective cation exchange membranes (MVS-CEMs). In "Tuning the Ion-Selectivity of Thin-Film Composite Nanofiltration Membranes by Molecular Layer Deposition of Alucone", the Edri and Nir groups modified a commercially available NF membrane. Nanofiltration forces water through a membrane like reverse osmosis does, but the membrane is more permeable to desired ions like Mg^{2+} than undesired ones like Na^{+}. To improve the selectivity of the membrane, alucone was deposited on it by MLD in a GEMStar ALD system. At the pH of the brackish feedwater used, the modified surface of the membrane exhibited more positive charge. This increased the passage of $MgSO_4$ relative to NaCl by approximately 2x.

In "Low-resistance monovalent-selective cation exchange membranes prepared using molecular layer deposition for energy-efficient ion separations," Dr. Edri and Dr. Nir apply alucone thin films as ion selective active layers in MVS-CEMs used in electrodialisys desalination where ions are drawn through a membrane by an electric field. By tuning the thickness and surface charge of the alucone layer, more monovalent ions like sodium can be allowed to pass through the membrane while desired bi- or multivalent ions are blocked. At the same time, the overall ionic resistivity was not significantly increased, minimizing the energy consumption of the process.

Click here to learn more about Dr. Edri's group which focusses on technologies to harness solar energy, or here to learn more about Dr. Nir's water filtration group. If you would like to inquire about a GEMStar ALD system or foundry ALD film deposition services, please contact Arradiance here. The GEMStar features dual manifolds, preventing MLD precursors from prematurely reacting, contaminating the system. The hot-wall chamber enables the deposition of conformal MLD/ALD films over high aspect ratio, high surface area substrates such as the porous membranes used in this study.