## 421d Mineral Salt Crystallization on Ro Membranes and Surrogate Surfaces

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Reverse osmosis membranes used for surface and groundwater desalination are prone to mineral salt scaling. Development of advanced scaling resistant membranes will require to first understand why membranes scale and what factors contribute to surface mineral scaling. The parameters that affect the scale mineralization process include operating conditions and membrane surface properties. In order to separate the effects of operating conditions and membrane properties (e.g., surface roughness and surface charge), an experimental approach was developed to evaluate membrane scaling propensity. Membrane scaling propensity was evaluated in terms of flux decline, surface mass density of mineral salt crystals that scale the membrane surface, surface scale coverage measurements, quantification of surface crystal axial growth and crystal morphology. The present study focuses on calcium sulfate (gypsum form) surface crystallization. Gypsum is a mineral salt that forms a tenacious scale and unlike the common mineral salt scalant, calcium carbonate, its mitigation by feed pH adjustment is ineffective.

In order to separate the contribution of bulk crystallization and surface crystallization to membrane scaling, studies with and without retentate and feed microfiltration were conducted. Filtration of retentate minimized the contribution of bulk crystals to surface scale formation. In addition to RO membrane scaling studies, surface crystallization studies were conducted on surrogate surfaces (of different chemical functionalities) deposited onto the surface of a quartz microcrystal sensor. It has been suggested in the literature that surface scale formation is affected by surface chemistry (i.e., surface chemical functional groups) and surface roughness. In order to cover a range of surface chemical functionalities, surrogate surfaces were prepared that consist of anionic and cationic polyelectrolytes. The polyelectrolyte-modified surfaces were created by alternate deposition, via spin-coating cationic and anionic polymer layers, onto silicon wafers and quartz crystal sensors. The approach was used to create positively or negatively charged macromolecular surface films that are 5-500nm thick. In addition to polyelectrolyte multilayer deposition, polystyrene was also used as control due to its nonpolar and hydrophobic nature. Crystallization studies with these modified-surfaces were conducted in model solutions at low supersaturation (S.I. 1-3) with respect to gypsum in order to minimize deposition of large crystals that may have formed in the bulk solution. Quantitative kinetic studies of gypsum surface crystallization were conducted in quartz crystal microbalance flow cells in an impinging jet configuration.

The buildup of gypsum scale on polymer-modified templates was determined by percent surface coverage, and the distribution of crystals surface density and size to assess the uniformity of coverage. The results of the study have revealed that surface functionality has a significant and measurable impact on the degree of surface crystallization by gypsum. The results suggest that there is merit in exploring the potential for designing membranes of surface morphology and chemical functionality to specifically mitigate the current problem of RO mineral salt scaling in membrane desalination of high salinity surface and ground waters.