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In-situ studies of thin-film composite reverse osmosis membranes with small-angle neutron scattering during the process of desalination

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Summary

Formation of aggregates caused by the interaction of organic and inorganic molecules, in particular those involved in the formation of calcium phosphate minerals, has strong negative influence on membrane permeability in reverse osmosis (RO) wastewater desalination. Presently, RO is a major technology for water desalination and recovery. A better understanding of the origin of these aggregates is needed for economic reason as well as for scientific purpose as these phenomena are very much related to the broad field of biomineralization [1]. Small-angle neutron scattering (SANS) along with the technique of SANS contrast variation is a strong tool in this field as it is a non-destructive technique allowing quantitative analysis on a microscopic scale and the distinction between organic and inorganic components.

One of our goals is the realization of in-operando SANS experiments on RO desalination at close to realistic conditions. For this purpose we developed a cell for real-time SANS experiments simulating the process of RO-wastewater desalination up to 30 bar as described in Ref.[2].

The scattering from three different sources has to be distinguished, namely from feed, the fouling layer at the surface of the membrane, and from the membrane itself. It is shown that the scattering from RO membranes is very strong and dominating. Membrane performance was determined in parallel to SANS by measuring water permeability and rejection.

A short description of the in-operando cell as well as SANS data from various topics of this project will be presented. These are: (i) Formation and characterization of aggregates formed in a simulated secondary effluent after adding various organic molecules [3-5], (ii) characterization of RO thin-film composite (TFC) membranes using SANS contrast variation , and, (iii) results from desalination experiments performed at the classical and very-small angle scattering SANS instruments KWS1 and KWS3 of the FRM II (TUM in Garching).

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