Experimental report

10/05/2019

Proposal: 9-13-739 **Council:** 4/2017

Title: SANS characterization of aquaporin-containing silica-reinforced PC liposomes for use in energy-efficientand selective water filtration

Research area: Soft condensed matter

This proposal is a new proposal

Main proposer: **Martin ANDERSSON**

Experimental team: Simon ISAKSSON
Fredrik BORJESSON SANDEN

Local contacts: Sylvain PREVOST

Samples: proteoliposils
Proteoliposomes

Instrument	Requested days	Allocated days	From	To
D11	3	1	19/06/2018	20/06/2018

Abstract:

Despite the abundancy of sea water there are 663 million people that lack access to safe drinking water. This problem is attributed to excessive energy consumption and hence cost coupled to desalination of sea water into drinking water. Calculations show that the energy consumption of water desalination can be reduced to one third, which would make a significant impact on safe drinking water availability. We use biomimicry to develop an energy-efficient desalination filter which is based on aquaporins, water channeling proteins that transport water across the cell membrane. We have stabilized functional aquaporins in the lipid bilayer of vesicles and are now aiming for improving the system in terms of robustness. We are doing so by introducing silica in the bilayer surrounding the aquaporins. In this proposal, we aim to study the composition of silicified aquaporin-containing PC bilayers using SANS. We are also eager to investigate if silicification alters the conformation of the aquaporins, which possess both transmembrane domains and extracellular domains. In addition to filter development, this study is of more general interest in terms of transmembrane protein stabilization.

Experimental report ILL 9-13-739

Experimental team: Simon Isaksson and Fredrik Börjesson Sandén, Chalmers University of Technology, Gothenburg, Sweden
Local ILL contact: Sylvain Prévost
Beamtime date: 2018-06-19 to 2018-06-20

This one-day beamtime ended up being successful owing to preliminary studies conducted during 5 days at the FRMII in Garching, Germany. The key to the success of the ILL beamtime was the rotating holder that allowed sample sedimentation to be impared.

The aim of the experiment was to study the process in which proteoliposomes consisting of the transmembrane protein aquaporin and POPC lipids are coated in a thin shell made from silica. Special attention was directed towards the interaction of the silica shell with the proteins and lipids as well as the kinetics of the shell build up process.

We were successfully able to conduct the experiments that we set out to perform and found both expected and intriguing differences in the reduced data from the experiment. We performed full characterizations (using λ=5Å and detector positions 39m, 8m, and 1.4m) on liposomes, proteoliposomes and their silicified versions as well as time dependent silica shell build up studies at 5m. We also ran some trials using λ=20Å at 39m to capture the aggregate size of the silicified proteoliposomes, but they were larger than that. The rotational holder (tumbling rack) was of great importance because a cuvette rotation of ~5.5rpm maintained the sample in the path of the beam despite sedimenting upon forming large aggregates. The kinetics data was captured as frequently as possible while cycling between 4 samples. 2 min at each sample at the time was enough to get good statistics and the silicification process was designed to be slow enough to be captured satisfactorily at this acquisition speed. Both the kinetics experiments and the full characterizations were performed in both D2O and CMSiO2 (Contrast matched to Silica).

The results have been submitted and peer reviewed but are not published yet. The SANS evaluation part has however been well received by the reviewers, which indicated that this experiment resulted in good quality data and an interesting outcome. We were able to conclude that the lipid bilayer was largely intact upon silica shell formation, which is desirable for the incorporation of membrane proteins such as aquaporins.