Experimental report

26/07/2024

Proposal: 8-02-979 **Council:** 10/2022

Title: Interaction of supported phospholipid membranes with protein-corona covered silica nanoparticles

Research area: Biology

This proposal is a new proposal

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Samples: C40H80NO8P
SiO2 nanoparticles
Human Serum Albumin protein

Instrument	Requested days	Allocated days	From	To
D17	4	0		
FIGARO	4	2	04/06/2023	06/06/2023

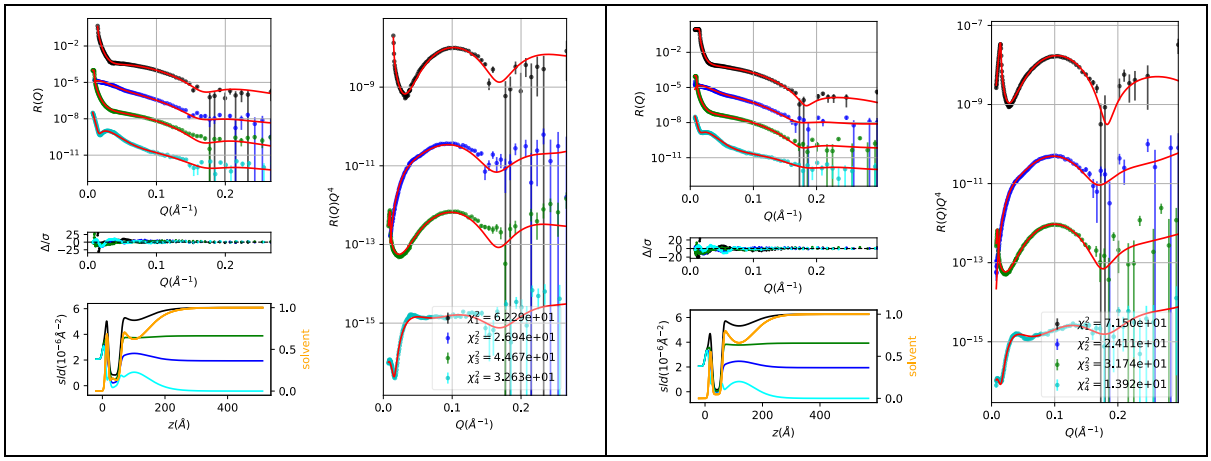
Abstract:

Interaction of bio-membranes with inorganic nanoparticles presents great interest in relation to practical applications in nanomedicine and nanotoxicology. Motivated by a previous Neutron Spin Echo study (Hoffmann et al. Nanoscale 2014, 6, 6945) where the surprising finding of phospholipid membrane softening (reduction of bending rigidity) under the binding of silica nanoparticles (SiNP) was reported, we have performed a series of experiments and molecular dynamics simulations, aiming at the elucidation of the structural aspects of the interaction between SiNP and supported phospholipid membranes. Our results indicate that local membrane disorder due to SiNP attachment is related to the observed dynamic behavior. Our intension with this proposal is to further exploit the power of the multiple solvent-contrast neutron reflectivity technique and to extend our investigation in the case of SiNP coated by a protein corona, that represents a scenario of high biological relevance.

Experimental report

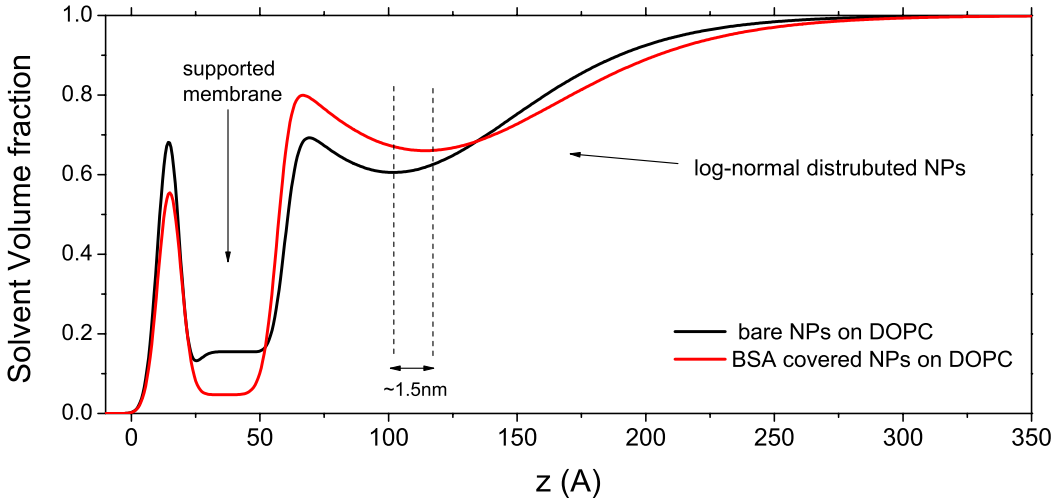
According to the initial experimental plan during the beamtime at FIGARO we have studied the interaction of supported DOPC membranes with incoming hydrophilic silica nanoparticles as a function of the presence of a protein corona around the NPs. Vesicle fusion of DOPC vesicles on silicon substrates produced supported bilayers of adequate coverage as evidenced by neutron reflectivity characterization with 3 contrasts. Then the effect on BSA protein in solution was investigated by measurements in D2O, where as expected by QCM pre-characterization of the system, no interactions take place.

Then by introducing NPs with or without a protein corona, we investigated the resulting structure at the interface and any potential destabilization of the membranes (see fitted 4-contrast results below).



(left) bare silica NPs on DOPC membranes (right) protein corona covered silica NPs on DOPC membranes.

The resulting sld profiles at the interface (see below) give a quite precise picture of the interfacial structure that is also compatible with the size and size distribution of the NPs as measured by SAXS and SANS. Both types of NPs adsorb on the membrane with the BSA coated NPs having a 1.5nm “gap” from the membrane. It would have been beneficial if one of the too supported membranes did not had an about 85% surface coverage, however still the results are informative about the underlying effects.



Sld profiles that result from the global fit of 4-contrasts with a 4-layer membrane model plus log-normally size distributed Si NPs on top.

From the fitted models it seems that in general the presence of the protein corona screens the NP/membrane interaction in a way that leads to a “weaker” attachment (as previous postulated by our QCM with dissipation measurements). Trials are underway for a DOPC vesicle leakage assay (with a fluorescent probe) in the presence of bare/coated NPs that will complement presented measurements and quite probably will lead to the preparation of a journal article.