Bilayers at the ILL

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Transmigration of non-ionic synthetic polymers through lipid membranes

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Polymers with balanced hydrophilicity can translocate through biological membranes without doing damage. In the case of synthetic polymers there are only few reports of translocation using charged polymers [1-2]. For non-charged polymers translocation phenomena were predicted theoretically [3] but not verified experimentally.
We have synthesized such balanced, alternating hydrophobic/hydrophilic polymers and studied their translocation properties as well as the interactions with lipid membranes using Pulsed Field Gradient (PFG) NMR, QCM-D and scattering techniques.
The investigated polymers contain polyethylene glycol (PEG) as a hydrophilic part and dicarboxylic acids as the hydrophobic one. As a model cell membrane we used unilamellar liposomes of different lipids (DOPC, POPC, DMPC).
Translocation properties were measured by PFG NMR and analyzed by a two-phase diffusion model [5]. Two dynamical phases of the polymers were observed in their mixture with liposomes (Fig. 1). One phase is attributed to the free polymers and the other one characterizes their interaction with liposomes. The time dependence of the ratio between these two phases indicates the translocation process. The exchange process was observed in the time range from 50 to 900 ms.
Using the two-phase diffusion model, the dependence of translocation time on the polymer molecular weight and liposome composition was studied. The calculations show a slight increase of the exchange time with increasing of polymer molecular weight and strong dependence of the exchange time on thickness of lipid bilayer.
Currently neutron scattering experiments are in progress to understand the mechanism of polymer translocation through the membrane. First SANS results under different contrast conditions indicate distinct interactions between the polymers and the lipid membrane.
Because of the non-ionic nature of the polymers only small interactions with biological compounds are expected and the materials might be interesting candidates for drug delivery and other applications.

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