ESRF	**Experiment title:** Structural characterization of single supported membranes on polymer cushions: Reflectivity at the solid-liquid interface	**Experiment number:** SC-1635
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Report:

We have used a recently developed microfluidic setup [1] for reflectivity studies of single supported membranes in aqueous environment. Thin polymer layers on silicon oxide were used as soft supports for the membrane.

The reflectivity data show that we were able to produce homogeneous membranes on rigid supports such as silicon oxide [2] but also on smooth, soft cushions. Such cushions are important since they help to reduce denaturation effects of the membrane in contact with hard supports.

We have chosen polyelectrolytes such as PAH (polyallylamine hydrochloride, positive net charge) which self-assemble to form well-defined layers on substrates with a negative net charge such as silicon [3]. These layers retain a very high water content if not dried after the self-assembly process, which makes them virtually invisible for x-ray reflectivity since there is negligible electron density contrast between the PAH-layer and the excess water, see Fig. 1(a).

A lipid membrane of 1,2-Dioleoyl-sn-Glycero-3-Phospho-L-Serine (DOPS, negative net charge) was successfully deposited on the polymer cushion by the method of vesicle fusion [4]. The reflectivity of the membrane on PAH (Fig. 1(b)) and the corresponding electron density profile (Fig. 1(c)) show that the membrane is virtually floating above the substrate. In particular, the PAH-layer retains the interface roughness of the bare silicon substrate (≈ 4 Å), which allows to record the reflectivity of such floating membranes up to a momentum transfer of $q_z = 0.5$ Å^{-1}.

Hence, we have demonstrated that such cushions can act as aqueous "sponges" to provide a well defined model system for surface diffraction studies of virtual floating lipid membranes, which retain to a wide extent the properties of real cell membranes.

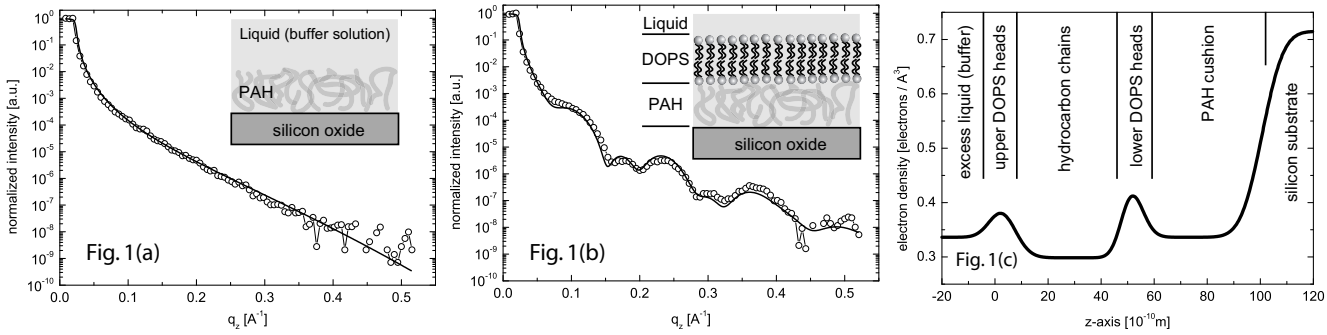

Fig. 1(a): Reflectivity of a PAH-layer deposited on SiO_2 in excess water. No characteristic oscillations are visible. (b) Reflectivity of a DOPS-bilayer floating on a PAH-cushion. The solid lines are fits to the data. (c) The electron density profile corresponding to the fit in Fig. 1(b).

Additionally, we have also studied the adhesion behavior of lipid membranes on less hydrophilic, rigid polymer substrates. Thermoplastics such as the cyclic olefin copolymer Topas are attractive supports for lipid membranes and promote vesicle fusion. Thin layers of Topas (ca. 450 Å thickness) were deposited by spin-coating on solid silicon substrates. Reflectivity data from the Topas/water interface display a loss of electron density contrast compared to data from the Topas/air interface (Fig. 2(a+b)). No swelling of the polymer in contact with water is observed.
The reflectivity of single membranes of 1,2-dioleoyl-*sn*-glycero-3-phosphatidylcholine, (DOPC, neutral) on Topas show a characterizing beating effect (Fig. 2(c)). The data cannot be simulated by a regular lipid bilayer nor a lipid monolayer model as initially expected. Instead, the data gives strong evidence that a previously unobserved "thinned" lipid bilayer structure with reduced packing density is formed on the thermoplastic substrate [5].

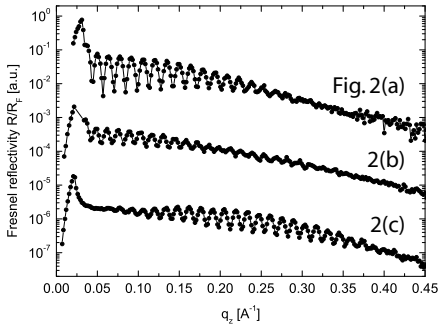

Fig. 2(a): Fresnel reflectivity of a Topas-layer on air. (b) Fresnel reflectivity of a Topas layer in excess water. (c) The Fresnel reflectivity of a DOPC membrane deposited on Topas in excess water shows a characteristic beating of the oscillations.

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