



Experiment title:

The behavior of lipid membranes at the solid-liquid interface under the influence of hydrostatic pressure and cosolvents

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Report:

We investigated the phase behavior of the phospholipid DMPC (1,2-Dimyristoyl-*sn*-glycero-3-phosphocholine) under high hydrostatic pressure. Until now, only the phase behavior of lipid vesicles in bulk solution under influence of high hydrostatic pressure (HHP) and temperature is known (see figure 1). The aim of the experiment was to extend this knowledge to solid-bound bi- and multilayers. For this purpose, we used high energy x-ray reflectivity measurements at the solid - liquid interface in order to extract the vertical electron density profiles. Pressures of up to 5 kbar were applied.

Our samples were prepared on silicon wafers by a spin coating process. The DMPC was dissolved in 2-propanol in different concentrations in the mg/ml range. Our reflectivity measurements at the solid - liquid interface were performed in a custom-made HHP cell [3] and at a photon energy of 70 keV. The liquid phase was purified water without cosolvents.

We measured both DMPC bi- and multilayers at temperatures of 30 °C and 37 °C. In figure 2, reflectivities of a DMPC multilayer and the corresponding electron density profiles are shown. The fits are only first approximations, but even here, it is visible that the number of layers decreases from nine to five layers during the first phase transition from the fluid L_{α} phase to the gel phase P_{β}' . With increasing pressure, changes in the electron density profiles (e.g. in the head group region) can be

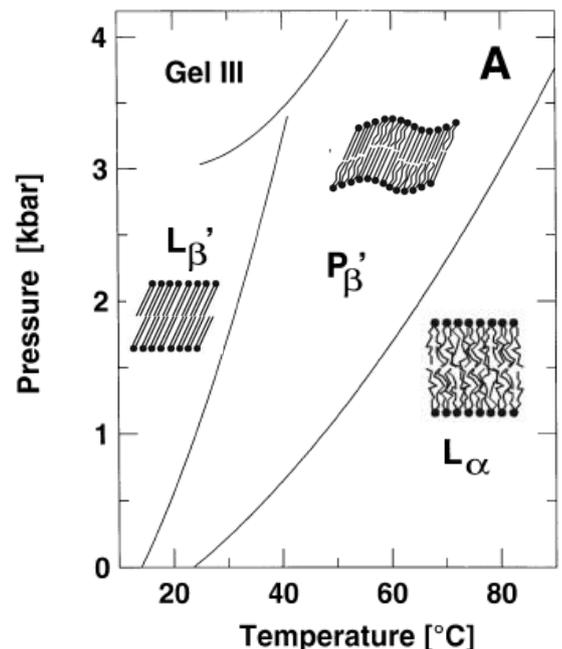


Figure 1: Phase diagramm of DMPC vesicles in solution [1], obtained by calorimetric measurements. Sketches from [2].

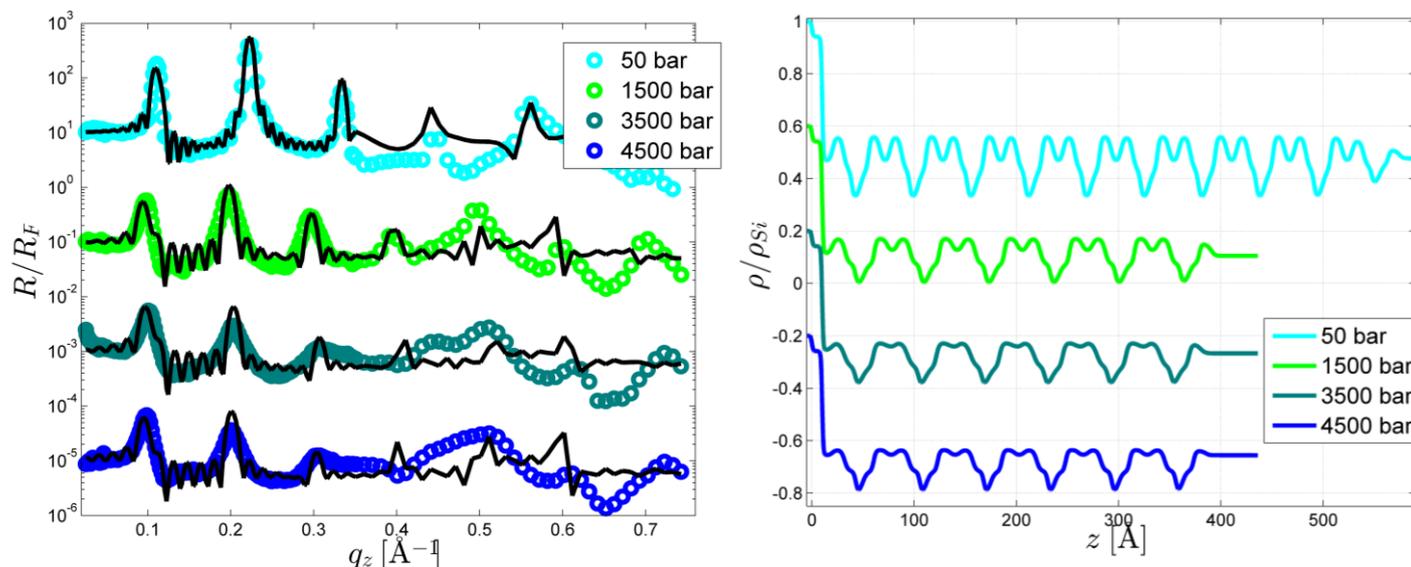


Figure 2: Left: X-ray reflectivity data of a DMPC multilayer at 37 °C and at different pressures. Right: Corresponding electron density profiles, obtained by a fit of the reflectivity data (black lines on the left).

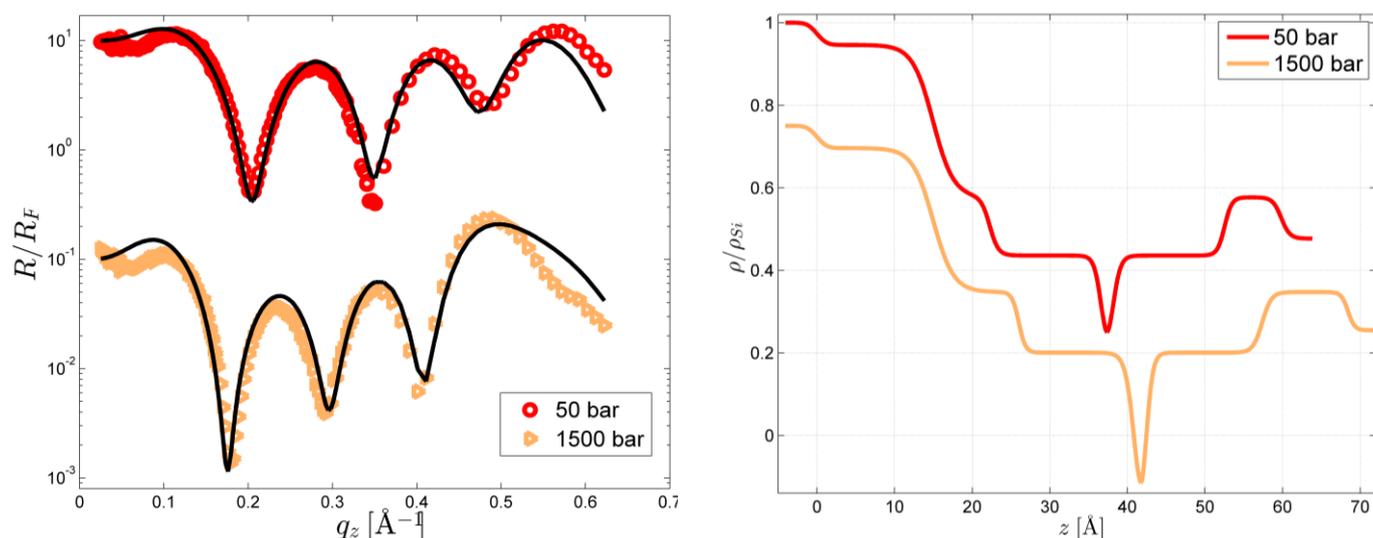


Figure 3: Left: X-ray reflectivity data of a DMPC bilayer at 37 °C at 50 bar and 1500 bar. Right: Corresponding electron density profiles obtained by a fit of the reflectivity data (black lines on the left)

distinguished. In our experiments, we also observed a reversible, pressure-induced multilayer growth (not shown). However, this phenomenon needs to be investigated in more detail in further experiments.

In figure 3, reflectivity curves and corresponding density profiles of a DMPC bilayer at 50 bar and 1500 bar are displayed. Here, it is also possible to identify the different phases of DMPC.

In summary, we were able to measure pressure induced phase transitions of DMPC bi- and multilayer at two temperatures. A region for DMPC multilayers growth was found at elevated pressures around 1000 bar.

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References

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- [2] R. Winter, C. Jeworrek, *Soft Matter* **5**, 3157–3173 (2009)
- [3] F.J. Wirkert et al. , *Journal of Synchrotron Radiation* **21**, 76-81 (2014)