Simultaneous Measurement of Surface and Bilayer Tension of Symmetric and Asymmetric Bilayer

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Free-standing lipid bilayers are one of the most used model systems to mimic biological cell membranes. Many experimental setups, like microfluidic chips, have been dedicated to produce such type of suspended lipid bilayers. To form a bilayer, we employ two aqueous fingers in a microfluidic chip surrounded by an oil phase that contains lipids. Upon pushing the aqueous fingers into the microfluidic device their interface gets decorated with a monolayer and eventually zip to form a bilayer when the monolayers get in nanoscopic contact to each other [1]. The bilayer life time is limited to about one hour by a slow drainage of the oily phase into the microfluidic device material consisting of PDMS (Sylgard 184). Using a pressure controlled system the drainage can be minimized resulting in superior bilayer stability and life times of several hours. Applying different pressures to the aqueous fingers in the microfluidic chip, the bilayer can be bent at a desired curvature. Extracting the contact angle and the resulting curvature of the bilayer region as well as of the monolayer regions for a given applied pressure difference, both the bilayer tension and the surface tension of the lipid monolayer can be derived using Young Laplace pressure equation. This approach works also for asymmetric bilayer and enables to directly obtain the tension of asymmetric bilayer.

[1] S. Thutupalli, J.-B. Fleury, A. Steinberger, S. Herminghaus, and R. Seemann; “Why can artificial membranes be fabricated so rapidly in microfluidics?” Chem. Commun. 49, 1443 (2013).