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Thermodynamic stability of supported lipid bilayers on atomically smooth surfaces

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Supported lipid bilayers (with or without membrane proteins) on solid surfaces have promising potential for bio-sensing applications, unique separation processes, and can be used as simplified models to study biological membranes. The simplest technique to prepare supported lipid bilayer is illustrated in Figure 1, and is often called ‘vesicle fusion’. In ‘vesicle fusion, lipids are first hydrated in aqueous solution to allow the self-assembly of vesicles. These vesicles then adhere to the surface, rupture, and fuse into supported lipid bilayer. It is often assumed that the vesicles fuse into a continuous lipid bilayer; however, AFM studies show that upon vesicle fusion, lipids can adapt different structures, such as (1) patchy lipid bilayer, (2) lipid bilayer with holes (defects), (3) continues lipid bilayer, (4) multilayer lipid membrane or (5) layer of intact vesicles on the surface. Importantly, some applications require specific lipid structure. For instance, for separation processes the lipid bilayer must be continuous (defect-free); yet, there is no clear understanding what is the thermodynamically favorable lipid configuration on the surface for a given system (lipid composition, ionic composition, pH, temperature and surface chemistry). During the talk the author will present a simple, yet quantitative mechanism for vesicle fusion on atomically smooth hydrophilic surfaces, such as silica or mica. The model takes into account the adhesion energy between the lipids and the surface, the line tension and the bending modulus of the lipid bilayer. The model can be used to determine whether patchy lipid bilayer, lipid bilayer with holes, or continuous lipid bilayer is the thermodynamically favorable configuration. Then, AFM and impedance spectroscopy measurements will be presented in order to support the proposed mechanism. The proposed mechanism is expected to be useful for engineering the dynamics (rate of vesicles fusion) and thermodynamic stability (long lasting) of supported lipid bilayers for diverse applications.

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