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"Structure and dynamics of supported lipid bilayer membranes"

Lipid bilayers are fundamental structures of cell membranes, and provide reaction fields to membrane proteins relating to the transportation of signal, materials and energy into and/or out of cells. Artificial lipid bilayers on solid materials, called supported lipid bilayers (SLBs), are interfacial system between biomembranes and solid devices thus expected to be a platform for investigating membrane reaction. My research target is SLB formation on silicon and oxide substrates, and observation of dynamic processes in and on SLBs (e.g. lipid diffusion, domain formation/dissipation, peptides and protein assemblies) by using fluorescence-microscope-based techniques and atomic force microscope.

Theme1: Effects of substrate properties on supported lipid bilayer (SLB) formation and phase separation

SLBs are formed by vesicle fusion method in my lab. Substrates soaked in a suspension of lipid vesicles (=liposomes) are spontaneously coated by SLB through the vesicle transformation processes from sphere to planar membrane e.g. adsorption, fusion, rupture and spreading. In these processes, interaction between vesicles and substrates are critical factor thus SLB formation highly depends on the substrate conditions, vesicle size and lipid component. Understanding how the substrate physical and chemical properties (structures, roughness, charges, chemical termination, etc) affects to the SLB formation process, and furthermore the two dimensional structures in SLB, is essential for fabricating functional model biomembrane systems.

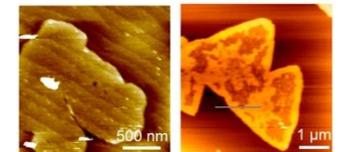
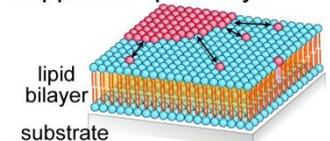
Keyword: lipid bilayers, surface forces, phase separation

Theme2: In situ observation of molecular diffusion in SLB

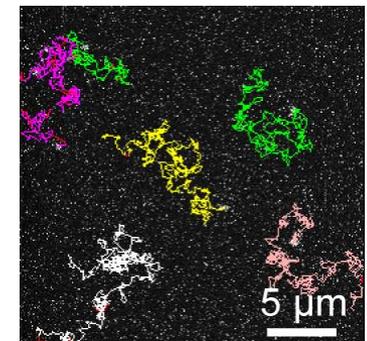
Lateral diffusion of lipid molecules in cell membranes is fundamental process of domain formation and membrane reactions. I use single molecule tracking (SMT) method to observe the lipid diffusion in SLBs in situ. In my experimental setup, SMT is achieved independent of the substrate transparency or refractive index, thus silicon, TiO₂ and other oxide materials are available. SMT on nano-structured oxide surfaces are currently underway.

Keyword: molecular diffusion, total internal reflection microscope

Supported lipid bilayer



Schematic of supported lipid bilayer (SLB), and AFM topographs of SLBs with two-dimensional domains.



Diffusion trajectories of fluorescence-labeled lipids in a SLB SiO₂/Si substrate