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Biphasic Nano-Domains of Planar Lipid Bilayer Complexed with Fluorogenic Polymer Reporter Tailored for Antimicrobial Detection

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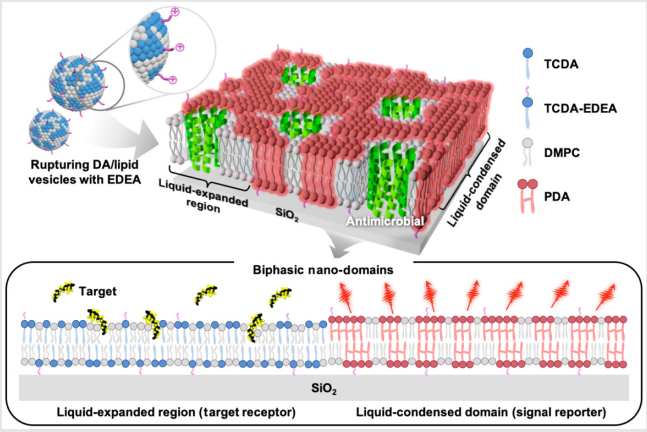
We have fabricated an unexpected type of supported planar bilayer composed of receptor phospholipids and single-chained diacetylenes as fluorogenic reporters using protruded anchor moieties with a positive terminal charge. Nanoscale topographical and surface thermodynamic analyses, as well as molecular dynamics simulations, revealed the coexistence of well-dispersed liquid-condensed (L_c) domains forming nano-islands and liquid-expanded (L_e) region in the planar bilayer, enhancing sensitivity against a prototype of ubiquitous membrane-associated antimicrobial peptides, melittin. The L_e regions, acting as target receptors, enabled sensitive detection as the melittin adsorbed and inserted into these regions due to strong hydrophobic interactions between phospholipids and melittin. The L_c domains, serving as signal reporters, enabled diacetylenes to assemble, polymerize, and fluoresce in response to the insertion of melittin into the L_e regions. Thus, biphasic nano-domains of the planar lipid bilayer finally endowed this sensor system with a detection range of 100 μM to 50 nM and a limit of detection (LOD) of ~37 nM for melittin. This exceeded the operational performance of the colorimetric polydiacetylene vesicle solution 45 times, which reportedly ranged from 100 to 4 μM with an LOD of ~1.7 μM.



Keywords: **biphasic nano-domain, supported lipid bilayer, fluorogenic polymer reporter, liquid-expanded region, liquid-condensed domain**

Introduction

Mimicking cell membranes is crucial for studying physiological processes occurring in intermembrane systems because natural cell membranes are too complex to study in their native forms.[1-4] Model cell membrane systems, such as black lipid membranes, Langmuir–Blodgett or Schaeffer (LB or LS) films, and supported lipid bilayers (SLBs), are easy to analyze as it is possible to control the environment of the systems and select