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Neutron and X-ray Scattering From Single Supported Lipid Bilayers: Reflectometry, Grazing Incidence In-Plane Diffraction and Off-Specular Scattering

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Biological membranes mediate transport and communication between the cell and its surroundings. They defend the cell against invasive agents, and most present day drugs interact with membrane components. Complexity of the cell membranes renders many of their characteristics impenetrable to fundamental physical studies. As a result, a significant emphasis has been placed on developing model lipid membranes that facilitate the physical and chemical characterization of particular membrane features. X-ray (XR) and neutron reflectivity (NR) and grazing incidence X-ray diffraction (GIXD) techniques can be utilized to measure the structure of single, supported lipid bilayers in bulk water. GIXD studies demonstrated that bilayers formed by vesicle fusion have more disorder in the inner leaflet compared to structures prepared using the Langmuir-Blodgett/Schaeffer (LB/S) technique. In both cases, only a modest water cushion was detected between the bilayer and substrate. Diffraction from in-plane ordered domains was observed from bilayers prepared by either technique. In the case of 1,2-Dipalmitoyl-sn-Glycero-3-Phosphocholine (DPPC) bilayers, the ordered domains were coupled across both leaflets, scattering as one entity. Contrastingly, the ordered domains were uncoupled in 1,2-Dipalmitoyl-sn-Glycero-3-Phosphoethanolamine (DPPE) bilayers. NR can be effectively used to study polymer-supported single lipid bilayers in bulk water. Using NR and fluorescence microscopy, we demonstrated that a hydrated, surface-tethered polymer network capable of five-fold change in thickness over a 25-37 C temperature range can be a novel support for single DPPC bilayers in a liquid environment. Moderate temperature change swells the polymer, lifting the membrane from the substrate, creating a nearly aqueous cushion. Additionally, as the polymer swells, it promotes both in- and out-of-plane undulations in the supported membrane. Off-specular neutron scattering was used to deduce the in-plane correlation length of the membrane distortions.