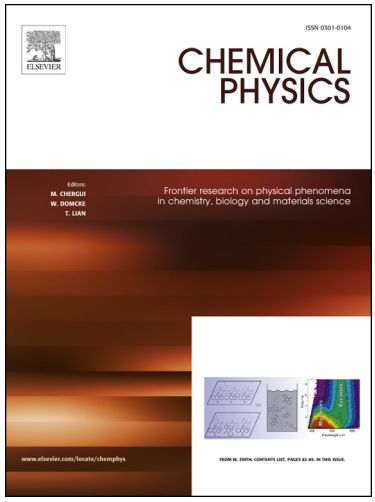

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Vibrational Studies of Saccharide-Induced Lipid Film Reorganization at Aqueous/Air Interfaces

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Abstract. Vibrational sum frequency generation (VSFG) and surface tension experiments were used to examine the effects of aqueous phase soluble saccharides on the structure and organization of insoluble lipid monolayers adsorbed to aqueous-air interfaces. Changes in dipalmitoylphosphocholine (DPPC) chain structure as a function of aqueous phase saccharide concentration and pH are reported. Complementary differential scanning calorimetry (DSC) measurements performed on solutions containing soluble saccharides and DPPC vesicles measured the effects of the saccharides on the lipid membrane phase behavior. Data show that the saccharides glucosamine and glucuronic acid induce a higher degree of organization in compressed DPPC monolayers regardless of the saccharide's charge.

Keywords: Phospholipid; Sum frequency generation; Cooperative adsorption; Isotherm; Calorimetry

Introduction

Lipid monolayers fulfill important biological and technological roles as they promote respiration in lung surfactant,[1-3] inhibit ocular tear evaporation,[4, 5] and serve as the simplest models for understanding fluidity, permeability, and miscibility in more complex biological membranes.[6-8] Additionally, lipid monolayers have been used as media to support sensor technologies.[9, 10] In each application, lipid film function depends sensitively on structure and organization within the monolayer.

Organization in lipid monolayers adsorbed to water/air interfaces depends sensitively on conditions of the aqueous sub-phase. Divalent cations such as Ca^{2+} and Zn^{2+} are known to induce lipid monolayer condensation,[11-13] whereas small antimicrobial peptides and simple surfactants intercalate into lipid films and induce structural disorder.[14-17] Recent studies have reported that simple, soluble biomolecules also show an affinity for lipid films. Solutes such as phenylalanine[18, 19] and trehalose[20] associate with lipid membranes, altering membrane permeability and phase behavior.

Recent studies have raised the prospect that solute interactions with insoluble lipid monolayers may even have meteorological consequences.[21] Sea spray aerosols (SSA) nucleate ice cloud condensation with an