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Low concentrations of negatively charged sub-micron particles alter the microstructure of DPPC at the air–water interface

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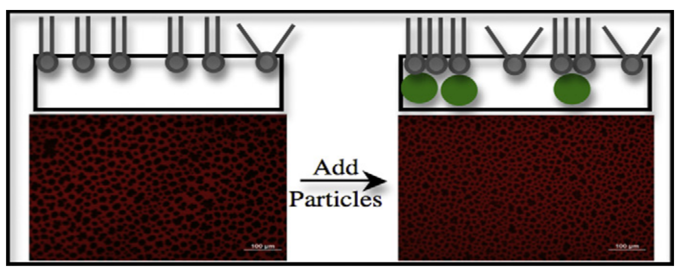
HIGHLIGHTS

- ▶ Negatively charged polystyrene particles did not alter DPPC monolayer collapse.
- ▶ Particles increased the hysteresis area of DPPC surface pressure isotherm during cycling.
- ▶ Particles resulted in smaller but more numerous condensed DPPC domains.
- ▶ Particles were associated with the condensed DPPC domains.

GRAPHICAL ABSTRACT



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ABSTRACT

The function of dipalmitoyl phosphatidylcholine (DPPC) Langmuir monolayers was studied after exposure to various concentrations of 200 nm carboxyl-modified polystyrene particles by a combination of surface pressure and surfactant microstructure studies. The presence of particles in the subphase at the lowest concentrations tested (10^{-5} to 10^{-4} g/L) did not influence the π–A isotherms. However, at the highest concentration (10^{-3} g/L), changes in the hysteresis areas of the isotherms were observed. The formation of LC domains during compression was significantly altered by the presence of the particles, resulting in the formation of smaller but more numerous domains. Fluorescence and atomic force microscopy images suggested that particles remained in the subphase but were closely associated with the condensed domains.

1. Introduction

Langmuir monolayers are insoluble layers of amphiphilic molecules spread on an air–water interface. When studied in a Langmuir trough, these monolayers provide a well-defined, two-dimensional medium where molecular orientation, packing density, phase behavior and surface tension (or pressure) can be controlled by controlling the surface area. Easy manipulation of molecular behavior makes these monolayers advantageous for mechanistic studies of molecular interactions, especially those of biomembranes [1–3]. The study of molecular interactions has been extended to investigate the effects of foreign material on the biophysical behavior of Langmuir monolayers [4–8]. Significant attention has recently been given to studies of sub-micron particle interactions with surfactant monolayers, which provides useful insights in various fields including occupational health [9], food [10], cosmetics [11], and pharmaceuticals [7,12].

Exposure to nano- and sub-micron particles can alter the biophysical behavior of surfactant films. Changes to surfactant

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