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LS-3-P-2778 Behavior of oxidized lipids in monolayers and Langmuir-Blodgett films studied by surface pressure measurements and Atomic Force Microscopy

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Some lipids are particularly sensitive to oxidation, such as unsaturated ones. The presence of oxidized lipids in cellular membranes or simplified membrane models promotes important changes in the lipid packing or in phase separation processes. Here, we study by Atomic Force Microscopy (AFM) the behavior of oxidized lipids in Langmuir-Blodgett (LB) films. LB films were transferred on hydrophilic mica surfaces, polar head groups of lipids being separated from mica by a thin water layer of 1 nm thick. We used two strategies : either following the evolution of LB films of an unsaturated phospholipid (palmitoyl-oleoyl-phosphatidylcholine, POPC) naturally ageing in contact of atmospheric oxygen, or incorporating a known amount of a defined oxidized derivative of POPC in POPC monolayers before their LB transfer (“mixed” monolayers and LB films). Two oxidized lipids were studied, PoxnoPC and PazePC, both characterized by a shortened oxidized chain ending with a polar group (aldehyde or carboxylic acid group, respectively).
First, homogenous AFM images of freshly prepared LB films of POPC confirm that this lipid is a homogenous liquid expanded phase. On the contrary, AFM images of naturally ageing POPC LB films show the appearance of small circular domains after 2 days of exposure to air. These domains (not observed if the samples are kept under vacuum) are characterized by a higher thickness (+0.8 nm) as compared to the intact POPC areas, likely due to a reversal of the more polar oxidized chain to be in contact with the water layer between the film and the mica surface.
In the case of mixed monolayers, surface pressure measurements show different results according to the polarity of the oxidized shorter chain. PazePC/POPC monolayers behave ideally (additivity of mean molecular areas taking into account the ratio of both molecules into the monolayer), whereas PoxnoPC induces an expansion of mixed monolayers. In all cases, AFM images are on the whole homogenous. However, they also show the presence of some higher circular spots (2-8 nm higher than the surrounding phase) in PazePC/POPC LB films suggesting the formation of aggregates of PazePC, ejected during the monolayer compression.
Finally, these results suggest a different behavior of oxidized lipids using the two strategies previously described. In particular, they support the hypothesis of a natural oxidation occurring in areas of POPC LB films presenting likely a looser packing or a defect.

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