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MAXWELL DISPLACEMENT CURRENT ACROSS LANGMUIR PHOSPHOLIPID AND AZOBENZENE MIXED MONOLAYERS BY PHOTOISOMERIZATION

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Abstract Mixed monolayers composed of phospholipid and fatty acid containing azobenzene on the water surface were investigated by means of the Maxwell displacement current (MDC) measuring method. The transient displacement current pulses were generated across mixed monolayers due to the photoisomerization of fatty acid containing azobenzene by alternating irradiation of ultraviolet and visible light. It was found that the current pulses were generated over the entire range of molecular area, and the maximum of MDC appeared at the molecular area just before the initial rise of surface pressure in both 1st and 2nd compression cycles.

Key words : Maxwell displacement current Langmuir photoisomerization phospholipid.

INTRODUCTION

Molecular switching between *cis*- and *trans*-forms in mono- and multilayer systems containing azobenzene is of particular interest in physics, chemistry and electronics.[1] We pay attention to the compression cycles and examine the difference in the generation of displacement current induced by the *cis-trans* photoisomerization in mixed monolayer systems with phospholipids and fatty acids containing azobenzene on the water surface. We then discuss MDCs

generated by photoisomerization in connection with compression cycles.

MATERIALS AND EXPERIMENTAL METHOD.

Materials and Experimental Setup

L-α-Dilauryl phosphatidylcholine (denoted as DLPC) and 4-octyl-4'-(5-carboxyl-penta-methyleneoxy)-azobenzene (denoted as 8A5H) were commercially supplied by Sigma and Dojin Kagaku, respectively.

Figure 1 shows a schematic diagram of the experimental setup used here.

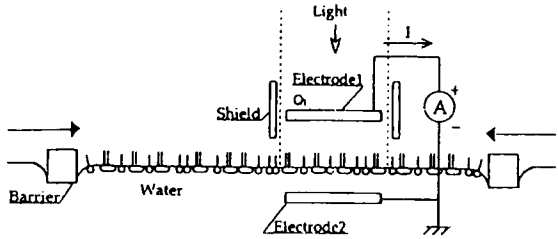

FIGURE 1 The experimental setup.

MDC Measurement

Monolayers composed of DLPC and 8A5H in molar ratios of 2:1 were spread from chloroform solutions with a concentration of 0.2 mole/liter on the surface of pure water in a Langmuuir trough using a microsyringe. The monolayers formed on the water surface were compressed with a constant barrier velocity α of 40.0 mm/min using two moving barriers. The MDC induced by photoisomerization was also measured in a similar manner reported previously.[2]

RESULTSAND DISCUSSION

MDC Measurement by Monolayer Compression

Figure 2 shows an example of MDC across DLPC and 8A5H mixed

monolayers in the molar ratio of 2:1 for DLPC:8A5H. Curves 1 and 2 represent the π-A, I-A and Q_I-A isotherms obtained during the 1st and 2nd monolayer compression, respectively. The MDC was measured in the range of molecular area A from 133.4 to 25Å^2 by monolayer compression at a constant speed of 40.0mm/min. As we can see in the figure, the initial rise of surface pressure and MDC peak shift about 20 Å^2 in a direction to the smaller molecular area with respect to the molecular area by cyclic monolayer compression.

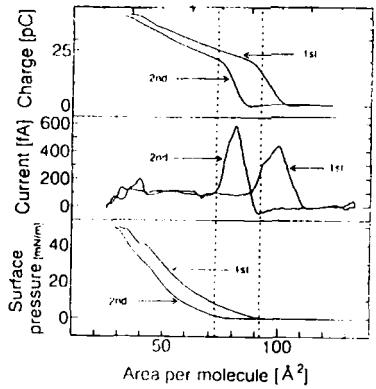

FIGURE 2 MDCs of DLPC-8A5H mixed monolayers of 1st and 2nd compression.

Displacement Current generated by the Photoirradiation

The displacement current was never generated from pure DLPC monolayers on a water surface by the photoirradiation, because the monolayers are not photoreactive.[3] Figure 3(a) was obtained for the DLPC and 8A5H mixed monolayers with a molar ratio of 2:1. The charge flowing through the circuit(Q1) during visible light irradiation is plotted against molecular area. As we can see in the figure, Q_I for the first monolayer compression cycle is greater than that for the second cycle in the range of molecular area A>100Å^2.

The generation of MDC is quite large in the molecular area before the initial rise of the surface pressure. Similar experimental relationships were obtained

for Q_1 during the ultraviolet light irradiation, as shown in figure 3(b).

From these experimental results, we concluded that it is effective to prepare mixed monolayers with the molecular area larger than that corresponding to the initial rise of the surface pressure.

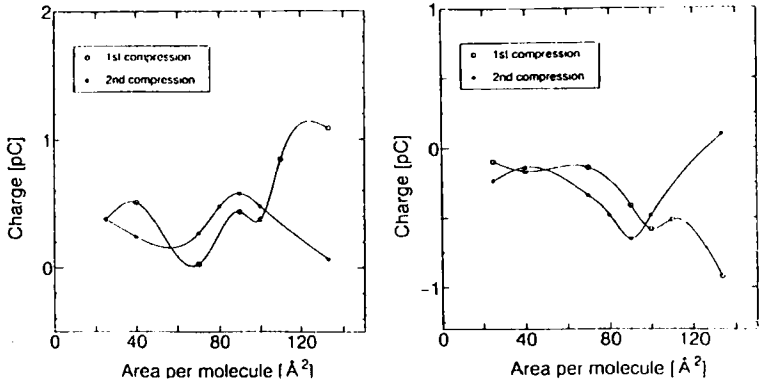

FIGURE 3 Relationship between Q_1 and A. (a) visible, and (b) UV light irradiation.

CONCLUSIONS

We applied the Maxwell displacement current measuring method to examine the generation of MDC due to the *cis-trans* photoisomerization in phospholipid-fatty acid containing azobenzene mixed monolayer systems on the water surface. We concluded that it is effective to prepare mixed monolayers with the molecular area larger than that corresponding to the initial rise of the surface pressure.

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