Adhesion signals of phospholipid vesicles at the electrified interface

Nadica Ivošević DeNardis[1], Vera Žutić[1], Vesna Svetličić[1], Ruža Frkanec[2], [1]*Ruđer Bošković Institute, POB 180, 10000 Zagreb, CROATIA,* [2]*Institute of Immunology, Inc., POB 266, 10000 Zagreb, CROATIA*

INTRODUCTION

Adhesion signals of individual phospholipid vesicles appear due to the double-layer charge displacement tracing vesicle transformation to a film of a finite surface area [1-3]. The key ingredient in amperometric measurement is the versatile potentiostatic control of adhesion forces by changing the surface charge and tension at the electrode/aqueous electrolyte interface. The adhesion force can be fine-tuned to study the interplay of complex processes involved in a deformable particle-electrode double-layer interactions. Our aim is to demonstrate that adhesion based detection is sensitive to polar head groups in phospholipid vesicles formed from phosphatidylcholine (PC) and phosphatidylserine (PS) lipid.

MATERIALS AND METHODS

Multilamellar DOPC (1,2-dioleoyl-*sn*-glycero-3-phosphocholine) and PS (1,2-diacyl-*sn*-glycero-3-phospho-L-serine) vesicles were prepared by dissolving 10 mg of lipid in 2 mL of chloroform. After rotary evaporation of the solvent, the remaining lipid film was dried in vacuum for an hour and then dispersed by gentle hand shaking in 1 ml of phosphate-buffered saline (PBS), 0.15 M, pH 7.47. Aliquot of suspension was added in deareated PBS in electrochemical vessel containing three electrode system. Electrochemical measurements were performed using a PAR 174A Polarographic Analyzer interfaced to a PC. Analog signals data acquisition was performed with DAQ card-AI-16-XE-50 (National Instruments) input device and the data were analyzed using the application developed in LabView 6.1 software.

RESULTS AND CONCLUSIONS

General adhesion behavior of multilamellar PC vesicles was examined in the wide potential range at mercury electrode (Figures 1 and 2). Presence of electrostatic interaction was identified based on: (i) signal frequency at the potential of zero charge (Epzc), (ii) signal direction at the Epzc, (iii) shifts of minimum signal frequency from the Epzc, (iv) critical interfacial tensions of adhesion and (v) appearance of bidirectional signals. The most interesting are bidirectional signals detected at the narrow potential range, close to Epzc (Figure 2B). Such signal is composed of: the negative portion due to vesicle spreading and the positive portion due to a specific interaction between the most exposed positively charged choline group of phospholipid polar head and the negatively charged electrode. Attenuation of the positive signal portion with increasing negative potential is due to the charge flow associated with vesicle spreading that dominates the charge flow associated to specific interaction of choline group. In contrast, adhesion signals of negatively charged PS vesicles are unidirectional.

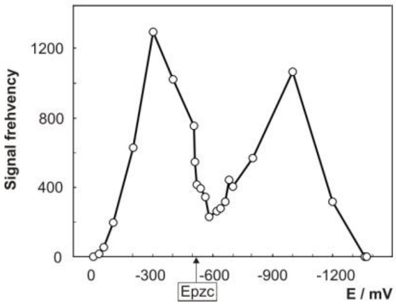

Figure 1: Potential dependence of signal frequency for multilamellar PC vesicles in PBS.

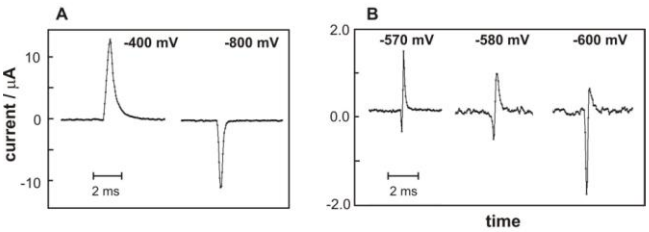

Figure 2: Adhesion signals of DOPC vesicles in PBS: (A) unidirectional and (B) bidirectional.

In conclusion, we were able to extract and differentiate electrostatic interaction of the polar head groups for zwitterionic PC and negatively charged PS vesicles.

REFERENCES

[1] V. Žutić, S. Kovač, J. Tomaić and V. Svetličić, Heterocoalescence between dispersed organic microdroplets and a charged conductive interface, *J. Electroanal. Chem*. vol. 349, pp. 173-186, 1993.

[2] V. Stauffer, R. Stoodley, J. O. Agak and D. Bizzotto, Adsorption of DOPC onto Hg from the G│S interface and from liposomal suspension, *J. Electroanal. Chem*. vol. 516, pp. 73-82, 2001.

[3] N. Ivošević DeNardis, V. Žutić, V. Svetličić, R. Frkanec and J. Tomašić, In situ amperometric characterization of liposome suspensions with concomitant oxygen reduction, *Electroanal*. vol. 19, pp. 2444-2450, 2007.