Liposome deformation derived by the differences in pH and/or ion strength between inside and outside of the vesicle

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Deformations of giant liposome induced by temperature and differences of osmotic pressure between inside and outside of liposome have been successfully explained based on models that consider the difference of occupied area between inner and outer phospholipid monolayer, whose pair composes bilayer membrane of liposome. However, there is little knowledge of relation among the real monolayer condition and the corresponding liposome deformation based on experimental discussions. In this study, we show that liposomes were deformed by difference of pH and ion strength between inside and outside of liposome, and compare these results with the corresponding monolayer properties, which are lateral elastic modulus and suitable occupied area of the monolayers. These monolayer properties were characterized by pressure vs area (\(\pi\)-A) isotherms measurement on the water surface adjusted the corresponding conditions for the solutions of liposome.

Giant liposome whose membrane is composed of DOPC(1,2-Dioleoyl-sn-glycero-3-phosphocholine) was prepared by the conventional method in glass capillary tubes. Buffer solutions to replace pH or ion strength (I.S.) in outside solution of liposome were prepared with MES(2-Morpholinoethanesulfonic acid) and NaOH (adjusted pH: 4, 6 and I.S: 1mM, 0.6M). Formation of liposomes was detected by a fluorescence microscope after touching the certain buffer solutions with the glass capillary end. The images were obtained every 2 second for 2 hour by CCD camera attached to the microscope. \(\pi\)-A isotherms of DOPC monolayer on various buffer solutions were measured by a lateral compression.

When the I.S. in outer liposome solution adjusted to 0.6 M, which is larger than the inner liposome (1mM) and pH was kept to 5.6, which is same with inner pH, liposomes condensed and then formed small protrusions. The monolayer on the solution with the same pH and I.S as those of the outer liposome expanded in comparison with that of the corresponding inner liposome. In contrast, liposome kept its outer shape and generated some small vesicles in the inside of liposome by touching the liposome to the solution of pH 3.5 and I.S of 1mM. The occupied area and the elasticity of the monolayer decreased in the monolayer adjusted the corresponding outer solution of liposome. Both change of the outer pH and I.S. to 3.5 and 0.6 M, respectively, allowed the liposomes to condense and relatively longer protrude (Fig.1). The monolayer on the corresponding solution to the outer liposome one has larger area and smaller elasticity than that at inner liposome. These results suggest that the origin of liposome deformation driving the difference in occupied area of monolayers are not only osmotic pressure but the condensed states in each monolayers composed of liposome membrane. The relationships between the shape deformations and the corresponding \(\pi\)-A isotherms also reasonably agree with the deformation theoretical remarks considering the difference of occupied area.

Fig.1 Liposome images before (up) and after deformation (down).