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<td>Author(s)</td>
<td>Yamada, N. L.; Torikai, N.</td>
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Kyoto University
Stable Disk-fused Vesicle in DMPC/DHPC Lipid Mixture System

High Energy Accelerator Research Organization N. L. Yamada¹, N. Torikai

Long-chain/short-chain lipid mixtures, where temperature plays a pivotal role in the formation of vesicles, disk micelles were spontaneously formed [1]. Recently, Nieh et al. have carried out small-angle neutron scattering (SANS) experiments on aqueous solutions of dimeristoyl-phosphatidylcholine (DMPC) and dihexanoylphosphatidylcholine (DHPC) mixture [2]. The experimental results showed that disk micelles at low temperature fuse into ULVs above the chain melting temperature, Tc, of DMPC molecules (about 24°C) in an adequate condition. Although disk-fused ULVs usually fissure into small disk micelles below Tc, it was shown that the ULVs were stable even below Tc at very low lipid concentration [3]. However, the mechanism of the stable ULV formation has not been clarified yet.

In this study, we investigated the structural change on a disk-fusion and vesicle-fission by SANS to understand the mechanism of the stable vesicle formation at low lipid concentration. The SANS experiment was performed with changing lipid concentration, cL, the molar ratio of DMPC to DHPC, q', and temperature. The sample temperature was increased from 20°C to 50°C on a disk-fusion process, and decreased to 20°C again on a vesicle-fission process. Figure 1 shows the cL-dependence of SANS profiles with changing temperature in case of q' = 3.2. From the SANS profiles, it was shown that the disk size increased with decreasing cL at 20°C before heating, and the vesicle size increased with increasing cL at 50°C. On the other hand, the SANS profiles at 20°C after heating were irreversible in case of low cL, and large disk micelles were observed. Moreover, stable ULV were observed in case of q' = 4.6 as shown by Nieh et al.

For the quantitative discussion, the relation between the disk radius at 20°C and the vesicle radius at 50°C for were shown in Fig. 2. In the disk-fusion process, the relation between the

¹E-mail: yamadan@post.kek.jp
Figure 1: Dependence of SANS profiles on lipid concentration, \( c_L \), with changing temperature, when the ratio of DMPC to DHPC, \( q' \), is 3.2.

Figure 2: (a) The relation between the disk radius at 20°C and the vesicle radius at 50°C. (b) Schematic illustration of disk-fusion and vesicle-fission process suggested by the experimental results.

disk- and vesicle-size is roughly on a master curve for all \( c_L \) and \( q' \). Whereas, the relation in the disk-fission process was different from that in the heating process: small disks and large disks were observed with decreasing \( c_L \). Remarkably, the relation between large disk- and vesicle-size was on another master curve, and the stable ULVs were observed in the crossover region of the two master curves at low \( c_L \). From these results, it can be said that the relation between disk- and vesicle-size is essential to understand the stability of disk-fused ULVs. The detailed discussion will be shown in the conference.

References