Tension-induced morphological transition in mixed lipid bilayers

Department of Chemistry, Tokyo Metropolitan Univ. N. Shimokawa[1] and S. Komura
School of Physics and Astronomy, Tel Aviv Univ. D. Andelman

近年、Rozovsky らは脂質二重膜における、超構造のダイナミクスについて報告した [1]。彼らは固体基板上に吸着したベシクルのドメインが、時間の経過とともにストライプ構造からヘキサゴナル構造へ転移することを蛍光顕微鏡により観察した。我々はこの構造転移がベシクルの吸着に伴う表面張力の増加に起因すると考え、曲率と組成が結合するモデルを提案する。その結果、図2のように張力の増加と転移の順序が対応していることを示す [2]。また張力の増加による転移を数値シミュレーションにより確認する。

Raft domains in biological cell membranes are associated with membrane signaling pathways and have attracted great deal of interest in recent years. Due to the complexity of biological membranes, a minimal model to investigate rafts (or more precisely, domain formation) consists of three-component lipid bilayers containing saturated and unsaturated lipids as well as cholesterol. These three-component systems have been investigated both at the air-water interface and in artificial vesicles. Complex phase separation and appearance of domains have been observed using fluorescence techniques. Such a phase separation occurs between a liquid-disordered phase rich in unsaturated lipid and a liquid-ordered phase rich in saturated lipid and cholesterol.

Recently, Rozovsky *et al.* reported on the morphology and dynamics of superstructures in three-component lipid bilayers containing saturated lipid, unsaturated lipid, and cholesterol as illustrated in Fig.1 [1]. We suggest that the observed sequence of the stripe to hexagonal morphological transition in mixed bilayers can be attributed to an enhanced membrane surface tension that is induced by the vesicle adhesion on the solid surface, as shown in Fig.2 [2]. We also confirm by numerical simulation that such a transition is induced by increasing the surface tension.

References

[1] S. Rozovsky, Y. Kaizuka, and J. T. Groves, J. Am. Chem. Soc. **127** (2005), 36.

[2] S. Komura, N. Shimokawa, and D. Andelman, Langmuir **22** (2006), 6771.

[1]E-mail: simokawa-naohumi@ed.tmu.ac.jp

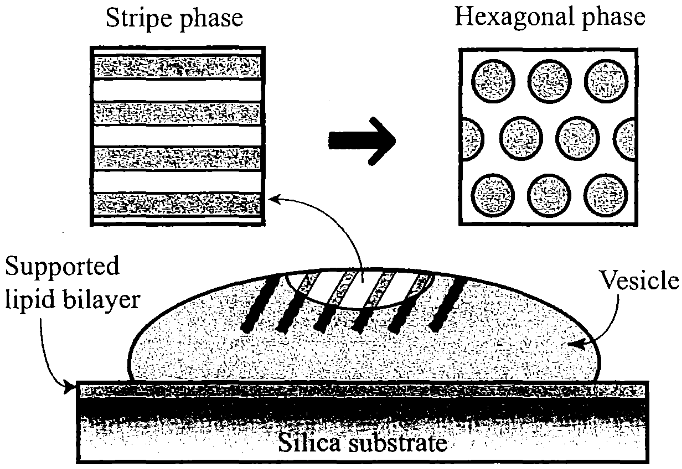

Figure 1: Schematic representation of a mixed vesicle adhering onto a supported lipid bilayer. The nonadhering upper region of the vesicle exhibits a morphological transition from a stripe phase to a hexagonal phase with elapse of time. The size of the vesicle is the order of 10μm, and the period of the modulation is roughly 1μm.

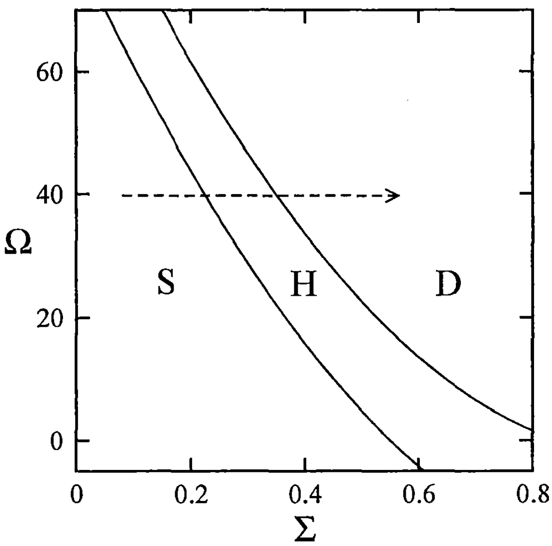

Figure 2: Mean-field phase diagram in the (Σ, Ω) plane. Σ represents the reduced surface tension and Ω the temperature-composition coupling parameter. The effect of increasing the surface tension is represented by the dashed right-hand arrow.