Numerical investigations on dynamics of two component vesicles

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After the pioneering works by Canham and Helfrich in 70's, increasing researchers have investigated theoretically and experimentally in depth the shape deformation of a homogeneous fluid membrane vesicle by the change of their environments such as temperature, pH and osmotic pressure. Recently, much attention has been paid to two component vesicles because such systems are considered to be ideal model systems to understand behaviors of real bio-membranes composed of several kinds of lipids and membrane proteins. In this context, Yanagisawa *et al* [1] has reported that the bending rigidity of a mixed vesicle depends on local composition of lipid, which crucially influences phase separations and vesicle deformations. In their experiments, shapes of vesicle are firstly controlled by applied osmotic pressure difference at a higher temperature where the membrane exhibits a single phase, and then the temperatures of the systems are lowered to undergo an intra-membrane phase separation. As results, they found a wide variety of shape deformation coupled with phase separations. In addition, various shapes induced by osmotic pressure difference, *e.g.*, prolate, oblate, tripod and starfish like shapes converge to oblate shapes by intra-membrane phase separation. The phenomenon is referred as *shape conversion*. It has also been reported by Sakuma *et al* [2] that a single pore by changing of temperature is formed in two component vesicles composed of cone- and cylinder-like lipids. They found a very novel phenomenon that the membrane on periphery of the pore rolls toward outside of the vesicle in a certain range of composition.

In the present work, we investigate numerically the effect of intra-membrane heterogeneity in lipid composition on dynamics of shape deformation of two component vesicle using a theoretical model that is extension of Canham-Helfrich bending elasticity model. In the present work, I concentrate on these two phenomena mentioned above, *i.e.*, dynamics of (1) "*shape conversion*" and (2) "*rolled rim formation on periphery of a pore*". For (1) the shape conversion, we numerically investigated the effect of the composition dependent bending rigidity on the shape deformation dynamics. We firstly prepared two types of initial shapes: (a) biconcave and (b) prolate dumbbell shapes by controlling osmotic pressure difference, and then changed the temperature to occur phase separations. We found that almost all the cases with prolate and oblate shape with different initial composition converge to pancake shapes after phase separation owing to the composition dependent bending rigidity. For (2) rolled rim formation, we present a new model to describe two component vesicles with a pore, where lipids can transfer between the inner and outer layers through the capped rim on periphery of the pore. Using the model, we performed numerical simulation and found that rolled rim can be induced by a local spontaneous curvature on periphery of the pore.

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REFERENCES

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