Construction of Giant Vesicle Containing Microspheres at High Volume Fraction and Its Transformation

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Keywords: Giant Vesicle, Microspheres, Phospholipid, Fluorescence microscopy

Giant vesicles (GVs), which are closed lipid bilayer compartments with cellular size, have much drawn attention as a container of cell model. In the cytoplasm, biological macromolecules occupy a sizeable fraction of the total volume of the media (typically 20–30 vol%), and the effects of this "crowded" state are important for their functions.[1] Crowding significantly influences two physicochemical features of the macromolecules: (i) thermodynamics stabilization to increases the free volume of the macromolecules, and (ii) changes in the mobility of the macromolecules. For the purpose of quantitatively understanding these features, GVs containing microspheres serve as valuable experimental model systems.[2]

Here our purpose is the preparation of GV containing microspheres at a variety of volume fractions and the clarification of the crowding effect for the GV transformation. Because the water-in-oil emulsion centrifugation method[4] is fast and easy for encapsulation of soft matter particles inside of GVs, we utilized it herein to encapsulate 1-μm microspheres with volume fractions in the range of 0–45 vol%.[5] GVs containing polymers or colloidal particles exhibit a unique transformation from an oblate (or prolate) spheroid to linked spheres after external stimuli such as osmolality change or electrical stimulation.[3,6] These findings are thought to be typical examples of the crowding effect for GVs concerning about the thermodynamics of the membrane bending energy and the entropic action of encapsulated particles. Here we found that GVs encapsulating 1-μm microspheres with a specific volume fraction transform from sphere to polygonal structure transiently after osmolality change. The fluorescence microscopy observation on GV membrane proved that this transient state associated with the tubular membrane protrusion apart from the GV. As far as we know, the polygonal structure of GVs is a characteristic shape only if GV contains polymerizable proteins such as actin or microtubules.[7] Although the mechanism of the transient polygonal structure of the GV is still veiled, the current finding can provide us a clue to clarify the crowding effect for the GV in a non-equilibrium state.

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