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Reversible photo-switching in a cell-sized vesicle

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In biological systems, change in the conformation of photosensitive molecules embedded in membranes, such as rhodopsin etc., play important physiological roles. Many studies have been conducted to prepare artificial photosensitive vesicles, and have reported changes in the permeability of ions and/or water-soluble compounds across the membrane upon photo-isomerization. In these studies, small vesicles (~100nm) have frequently been used, which implies that the direct observation of morphological change in individual vesicles is impossible. Unfortunately, these small vesicles are usually unstable due to their high curvature and undergo spontaneous changes such as fusion, breakdown, and aggregation even in the absence of external stimuli. In contrast, cell-sized vesicles (≥10 μm) are rather stable and can be used as a suitable model system for observing transformational processes and biochemical reactions inside them in real-time.

In this study, we designed and synthesized a photosensitive amphiphilic molecule containing azobenzene (KAON12); the conformation (trans or cis) of this molecule can be switched by light (Figure 1-a). Cell-sized vesicles were prepared from dioleoyl-phosphatidylcholine, DOPC, and KAON12 through natural swelling ([KAON12]/[DOPC] = 60 M/100 M). Photo-isomerization induces a change in membrane fluctuation behavior or a morphological transition between ellipsoid and bud shapes, depending on the asymmetrical degree of the initial shape. Figure 1-b shows the results of the photo-irradiation on an asymmetrical vesicle. After UV irradiation, the asymmetric vesicle exhibits budding. Interestingly, the budded vesicle transforms back to the original ellipsoidal shape upon treatment with green light. This reversible change in morphology

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Figure 1: (a) Chemical Formula of KAON12. (b) Photo-induced reversible ellipsoid-bud transition in a cell-sized vesicle. The transformation from ellipsoid to bud induced by UV light is shown (Upper). The reverse process from bud to ellipsoid induced by irradiation with green light is shown (Lower).

is observed more than ten times. While the pathways of the transformation are different somewhat between the forward and reverse processes, the switching between the two stable states is reversible. We evaluate a change in membrane area during photo-isomerization by measuring I-V-A curve, and discuss the mechanism of this reversible photo-switching in the vesicle morphology in relation to the effective cross-sectional area of the photosensitive molecule.

References
