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Sustainable colorimetric/luminescent sensors enabled by armored lipid nanoparticles

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Abstract

In this study, we developed a highly stable polymeric vesicle using a nanosilica-armor membrane to achieve a sustainable colorimetric/luminescent response. The silica armor can be grown directly as ~ 5 nm spherical nanoparticles on the surface of the diacetylene (DA) vesicle with liposomal structure. This can be accomplished via the modified Stöber reaction in pure water on a layer of amine linkers deposited on the vesicles. Once formed, the structural stability of the DA vesicles dramatically increased and remained so even in a dried powder form that could be stored for a period of approximately 6 months. Then, redispersed in water, the armored vesicles did not agglomerate because of the electric charge of the silica armor. After polymerization, the polydiacetylene (PDA) vesicles maintained an average of 87.4% their sensing capabilities compared to unstored vesicles. Furthermore, the silica membrane thickness can be controlled by reiteration of the electrostatic layer-by-layer approach and the direct hydrolysis of silica. As the number of silica armor membranes increases, the passage of the stimuli passing through the membranes becomes longer. Consequently, three layers of silica armor gave the PDA vesicles size-selective recognition to filter out external stimuli. These discoveries are expected to have large-scale effects in the chemo- and biosensor fields by applying protective layers to organic nanomaterials.

Keywords: Sustainable colorimetric sensing, Polydiacetylene nanoliposome, Silica armor, Layer-by-layer deposition, Size-selectivity

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