LOADING OF SILICA NANOPARTICLES IN BLOCK COPOLYMER VESICLES DURING POLYMERIZATION-INDUCED SELF-ASSEMBLY: ENCAPSULATION EFFICIENCY AND THERMALLY-TRIGGERED RELEASE

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Poly(glycerol monomethacrylate)-poly(2-hydroxypropyl methacrylate) diblock copolymer vesicles can be prepared in the form of concentrated aqueous dispersions via polymerization-induced self-assembly (PISA). In the present study, these syntheses are conducted in the presence of varying amounts of silica nanoparticles of approximately 18 nm diameter. This approach leads to encapsulation of up to hundreds of silica nanoparticles per vesicle. Silica has high electron contrast compared to the copolymer and its thermal stability enables quantification of the loading efficiency via thermogravimetric analysis. Encapsulation efficiencies can be obtained using disk centrifuge photosedimentometry, since the vesicle density increases at higher silica loadings while the mean vesicle diameter remains essentially unchanged. Small angle X-ray scattering (SAXS) is used to confirm silica encapsulation, since a structure factor is observed at q ~ 0.25 nm-1. A new two-population model provides satisfactory data fits to the SAXS patterns and allows the mean silica volume fraction within the vesicles to be determined. Finally, the thermo-responsive nature of the diblock copolymer enables thermally-triggered release of the encapsulated silica nanoparticles simply by cooling to 0-10 oC, which induces a morphological transition. These silica-loaded vesicles constitute a useful model system for understanding the encapsulation of globular proteins, enzymes or antibodies within block copolymer vesicles for potential biomedical applications. They may also serve as an active payload for self-healing hydrogels or repair of biological tissue. Finally, we also encapsulate a model globular protein, bovine serum albumin, and calculate its loading efficiency using fluorescence spectroscopy.