Tuning the Membrane Permeability of Polymersome Nanoreactors Developed by Aqueous Emulsion Polymerization-Induced Self-Assembly

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ABSTRACT

Polymeric vesicles (or polymersomes) are hollow bilayer structures consisting of an inner aqueous compartment enclosed by a hydrophobic membrane. Vesicular constructs are ubiquitous in nature and perform a variety of functions by compartmentalizing molecules into disparate environments. For polymer chemists, the synthesis of vesicles can be readily accomplished using polymerization-induced self-assembly (PISA), whereby pure vesicle morphologies can be easily accessed by tuning initial reaction parameters. Research into polymersomes is motivated primarily by the fact that hydrophilic cargo such as drug molecules, DNA, or enzymes can be encapsulated and protected from the often harsh conditions of the surrounding environment. A key factor governing the capability of vesicles to retain and protect their cargo is the permeability of their hydrophobic membrane.

Herein, we demonstrate that membrane permeability of enzyme-loaded epoxy-functionalized polymersomes synthesized by aqueous emulsion PISA can be modulated *via* epoxide ring-opening with various diamine cross-linkers and hydrophobic primary amines. In general, membrane cross-linking or amine conjugation resulted in increased polymersome membrane thickness. Membrane modification was also found to decrease permeability in all cases, as measured by enzymatically-catalyzed oxidation of an externally administered substrate. Functionalization with hydrophobic amines resulted in the largest reduction in enzyme activity, suggesting significant blocking of substrate diffusion into the central aqueous compartment. This procedurally facile strategy yields meaningful insight into how the chemical structure of the membrane influences permeability and thus could be generally applied to the formulation of polymeric vesicles for therapeutic applications.

REFERENCES

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