Combining the capsule-like protein thermosome with synthetic polymers to obtain nanoreactors and siRNA delivery agents

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Abstract

Protein cages, such as viral capsids, ferritins and chaperonins have become essential tools in bionanotechnology because of their well-defined, monodisperse, capsule-like structure. Combining them with synthetic polymers greatly expands the possibilities for their application.

The chaperonin thermosome (THS) is a hollow protein nanoparticle approx. 16 nm in diameter that can encapsulate macromolecular guests. Its unique features are two large pores (~7 nm) that allow diffusion of macromolecules into and out of the protein cage. Taking advantage of this intriguing nanostructure, the THS was developed into a nanoreactor for polymerization reactions that allows to confine atom transfer radical polymerization (ATRP) into the cavity of the protein. The polymers that were synthesized within the THS had a smaller molecular weight and a smaller molecular weight distribution than polymers synthesized in solution. Moreover, cationic polymers such as poly(amidoamine) (PAMAM) were conjugated into the THS, which converted the THS into a nanoreactor for the synthesis of gold nanoparticles. THS-polymer conjugates also proved to be promising delivery agents for small interfering RNA (siRNA). The polymer acted as an anchor for the oligonucleotide, allowing to load the THS with therapeutic payload. THS-polymer conjugates efficiently delivered siRNA into cells, while being less toxic than conventional transfection agents. These examples demonstrate that a wisely chosen combination of functional protein nanocapsules and polymers can lead to novel hybrid protein-polymer nanoparticles with advanced properties.

References

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