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Self-organization of biomolecular building blocks and inorganic nanoparticles into biohybrid nanomaterials

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Abstract:

Self-organization is a key tool for the construction of functional nanomaterials. We have recently established a novel method for the self-organization of biomolecular building blocks and nanoparticles. Here, protein containers, engineered with opposite surface charge, are used as an atomically precise ligand shell for the assembly of inorganic nanoparticles.[1] The assembly of these protein-nanoparticle composites yields highly ordered nanoparticle superlattices with unprecedented precision. The structure of the protein scaffold can be tuned with external stimuli such as metal ion concentration.[2] Importantly, the composite materials show catalytic activity inside the porous material.[3] Along these lines, the protein containers used as a scaffold offer a viable route towards renewable materials.[4] Towards the efficient preparation of nanoparticle-protein building blocks, we have recently established the encapsulation of inorganic nanoparticles into the protein container encapsulin.[5] For this purpose, gold nanoparticles were decorated with cargo-loading peptides. By lock-and-key interaction between the peptides and the peptide-binding pockets on the inner container surface, the nanoparticles are encapsulated with extremely high efficiency. Cargo-loading peptides may serve as generally applicable tool for efficient and specific encapsulation of cargo molecules into a protein compartment. Moreover, these nanoparticle protein-container composites are suitable for applications as building blocks in materials, exploiting the plasmonic properties of gold nanoparticles for light manipulation or sensing.

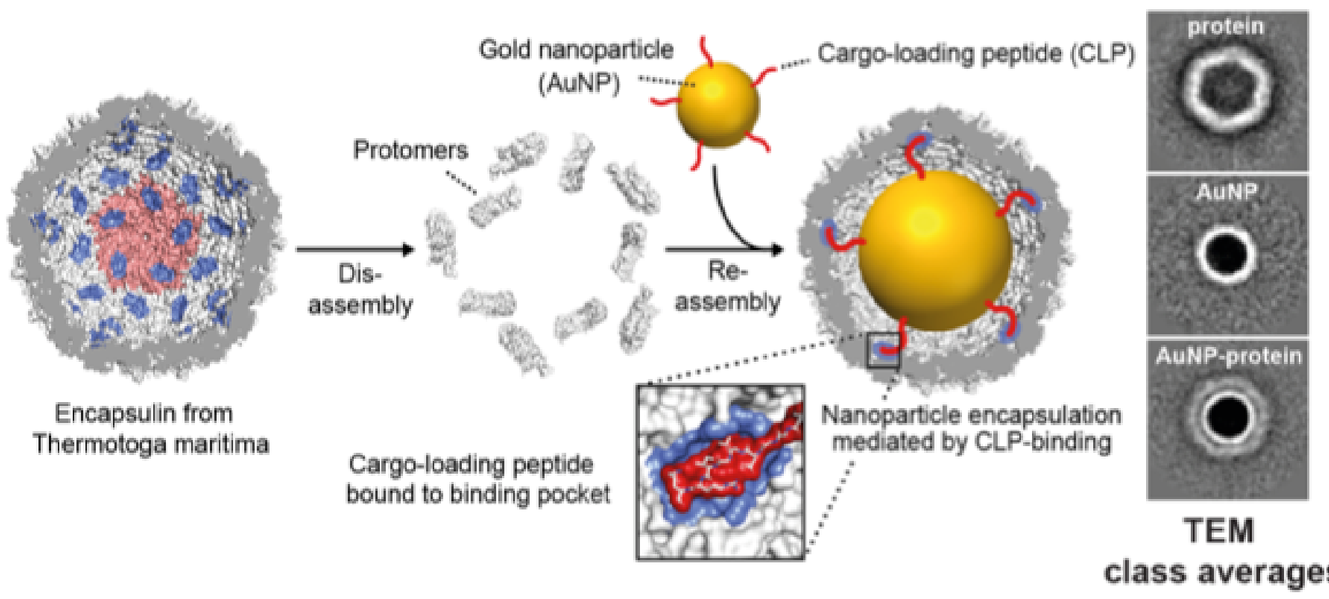

Figure 1. Self-assembly of protein-nanoparticle building blocks using supramolecular peptide binding

References:

[1] M. Künzle, T. Eckert, T. Beck, J. Am. Chem. Soc. 2016, 138, 12731-12734. [2] M. Künzle, T. Eckert, T. Beck, Inorg. Chem. 2018, 57, 13431-13436. [3] M. Lach, M. Künzle, T. Beck, Chem. Eur. J. 2017, 23, 17482-17486. [4] a) M. Künzle, M. Lach, T. Beck, Dalton Trans. 2018, 47, 10382-10387; b) M. Lach, M. Künzle, T. Beck, Biochemistry 2019, 58, 140-141. [5] M. Künzle, J. Mangler, M. Lach, T. Beck, Nanoscale 2018, 10, 22917-22926.

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