Protein and Peptide Chemistry for Nanotechnology:
Biomineralization, Crystallization, Patterning and Self-organization

Mitsuhiro Okuda[1,3], Kornelius Zeth[2,3] and Alexander Bittner[1,3]

CIC nanoGUNE, 20018, Donostia-San Sebastian, Basque Country, Spain[1]
Universidad del Pais Vasco (UPV/EHU), 48940, Leioa, Basque Country, Spain[2]
Ikerbasque, Basque Foundation for Science, 48011, Bilbao, Basque Country, Spain[3]
m.okuda@nanogune.eu

In biology, a huge number of protein and peptide molecules established self-organizing systems with sophisticated abilities, for example, detection of light by our eyes, and detection of sound by our ears. Therefore, our world can utilize such biomolecules to develop more complex structures for nanotechnology. On the way, we have developed fabrication methods for inorganic NPs and the assembly of the NPs, based on structure and function of proteins and peptides.

Biomineralization is one of the processes to build bio-inorganic materials such as bone and teeth. Some proteins can generate inorganic material through specific amino acid sequences, distributed in protein structures, which enable us to use them as **bio-cargos** for NPs. For example, the cage shape protein Dps (DNA binding protein in starved cell, diameter: 12 nm) can form metal oxide NPs within its cavity (diameter 5 nm) by assembling iron ions and nucleating NPs at specific sites [1]. The NP species can be changed by designing the synthesis solution, allowing for the fabrication of artificial NPs. There are many types of cage-shaped proteins in nature, such as ferritin and virus capsids (Fig.1). In addition, tube-shaped viruses such as TMV (Tobacco Mosaic Virus, inner diameter: 4 nm) can be used to fabricate rod-shaped inorganic NPs. Many types NPs and rods have been fabricated in such cavities.

NPs containing bio-cargos can self-assemble into two- or three-dimensional crystals through protein-protein interactions based on typical crystallization techniques [2]. In addition, the patterning of NPs can be optimized with bio-cargos functionalized using specific peptides. Peptides with certain biochemical functions can recognize the surface of specific inorganic materials [3]. A bio-cargo that is functionalized with such a peptide can be patterned on a surface of a target material. These protein and peptide techniques have been utilized to develop a range of devices [3].

In this talk, we will also show how to design self-organization systems through bio-cargo structures, and affinity peptides to fabricate complex NP structures.

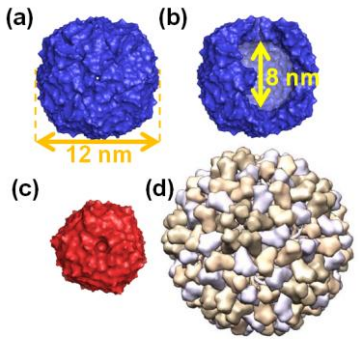

Figure 1. Schematics of apoferritin (a) viewed from the four fold symmetry axis. (b) shows the cavity. (c) Schematic drawing of Dps. (d) Schematic drawing of CCMV.

References

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