Binary protein crystals for the assembly of inorganic nanoparticle superlattices

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We report on the preparation of a new type of multifunctional biohybrid material using binary crystals from oppositely charged protein containers[1] for the precise arrangement of nanoparticles into highly ordered superlattices.[2] The engineered protein containers form binary crystals with a tetragonal lattice as shown by X-ray crystallography to high resolution. Prior to assembly, the cavities of the protein containers were used for the size-constrained synthesis of metal oxide nanoparticles. By assembling oppositely charged protein containers with nanoparticle cargo, highly ordered nanoparticle superlattices could be obtained. The composition and positioning of the nanoparticles in the crystals could be specifically controlled by combining protein containers with different nanoparticle cargo. The crystals could be readily fixated by glutaraldehyde crosslinking and were characterized using SAXS, SEM and EDX. As confirmed by SAXS analysis the crystal lattice is solely determined by the protein shell whereas functionality can be readily imparted by the choice of cargo. Self-assembling protein containers as atomically precise ligand shells therefore represent a robust and highly versatile system for the generation of high-quality nanoparticle superlattices.

1) T. Beck, S. Tetter, M. Künzle, D. Hilvert, *Angew. Chem. Int. Ed.* **2015**, *54*, 937-940.
2) M. Künzle, T. Eckert, T. Beck, *J. Am. Chem. Soc.* **2016**, *138*, 12731-12734.