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Using The Interfaces In Self-Assembled Protein Cage Architectures For Materials Synthesis

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The self-assembled architectures of viral capsids have been used as models for understanding processes of encapsulation of both hard and soft materials. We have explored modifications to the exterior and interior interfaces of viral (and other protein cage architectures) while maintaining the assembly of stable icosahedral capsid particles. This has allowed us to utilize the high symmetry of the viral capsid to engineer unique functionality for highly ordered multivalent presentation for controlled nucleation of hard inorganic materials and packaging of soft organic materials. Of particular interest is the nature of the hard-soft interface in these systems. Through the incorporation of peptides derived from phage display we can direct the nucleation and growth of specific inorganic phases, constrained within the protein cage architecture. The coupled synthesis of cage-constrained ferrimagnetic and antiferromagnetic nanoparticles results in formation of stable composites that exhibit unique exchange bias magnetic coupling. To understand the role of the protein in directing inorganic materials synthesis, we have probed the protein-mineral interface using genetic and chemical modifications, spatially controlled inorganic synthesis, high-resolution transmission electron microscopy, and cryo-electron microscopy and image reconstruction. The role of protein interfaces in these assembled protein cage architectures has been explored to understand and exploit packaging of a wide range of materials as diverse as nucleic acids, drugs, and inorganic nano-materials.