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De novo designed peptide and peptide-polymer conjugate for biomolecular materials

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Peptides, nature's "own" building blocks, provide control of functional groups over nanometer distances with sub-Angstrom resolution and can be de novo designed to self-assemble into multidimensional molecular constructs that mimic natural proteins or perform functions not found in nature. Conjugating synthetic polymers to peptides, forming peptide-polymer conjugates, takes advantages of both the stability and processibility of synthetic polymers and the built-in peptide functions. Helical bundles, a ubiquitous folding motif, underpin many structural and catalytic functions of natural proteins. By attaching a polymer chain to a helical bundle-forming peptide, the polymer chain will mediate the interactions between the helical bundle and its external environment, enable the macroscopic self-assembly and, potentially, allow the helical bundle to function in non-biological environments. A new design of peptide-polymer conjugates will be presented where the polymer chain is covalently linked to the side chain of the peptide. Upon attaching poly(ethylene glycol) (PEG) to the exterior of the helix bundle, the peptide secondary structure and also the tertiary structure, i.e. coiled-coil helix bundle formation, are stabilized. More importantly, using a photoactive heme-binding 4-helix bundle peptide as an example, this new design preserves the built-in functionalities in the interior of the helix bundle.