Title:	Peptide-based functional materials: from structural control to catalytic activities and inorganic-organic hybrids
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Abstract:	While most of the self-assembly processes in nature are controlled by out-of-equilibrium phenomena, the bottom-up self-assembly performed in the laboratories ismostly thermodynamically controlled. Recently, scientists have ramped up the efforts to design kinetically controlled systems where parameters such as solvents, temperatures, pH are found to be crucial to alter the nature of the self-assembly pathways. In the realm of bio-inspired material research, we take a cue from kinetically controlled, nucleation-growth mediated amyloid plaque formation and have designed short peptide fragments inspired from on A□42 amyloid nucleating core to perform stepwise self-assembly to yield materials with well-defined shape, dimensions, and properties. Peptides with amyloid nucleating core demonstrates stepwise self-assembly in water. Variation of temperature or solvent composition arrests the self-assembly in metastable nanoparticles, which shows self-assembly on a gradual increase in temperature and eventually produces kinetically controlled nanofibers and thermodynamically stable twisted helical bundles. Further, seeded supramolecular polymerization establishes a perfect control over the length/dimensions of the peptide nanostructures. Moreover, these self-assembled nanostructures are employed in the quest for new, robust enzyme mimetic biomaterials owing to their similarity of the native protein by means of amino acid as the building blocks. The designed self-assembled nanostructures obtained by grafting functional histidine on to the peptides mimic the active site of the robust artificial hydrolase enzyme to perform hydrolysis of the ester. Further, peptide-based nanostructures can be mineralized with bioactive glass composites to render inorganic-organic hybrid in rationale with collagen hydroxyapatite. The resulting composite hydrogel showed enhanced mechanical properties with self-healing nature in comparison to its native scaffolds by the mediation of hydroxyapatite formation. The biomaterial showed good biocompatibility towards U2OS and HaCaT cell lines.
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