IMPRS on Multiscale Biosystems

Project description

Title: Metal-coordinated self-healing peptide biomaterials
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Project description: Protein-based biopolymers (e.g. silk, mussel byssus) serve as valuable archetypes for the development of novel high performance materials. Recently, mussel byssal threads were discovered to harness protein-metal coordination bonds as transient mechanosensitive cross-links. These thermodynamically stable, but mechanically reversible bonds endow the material with remarkable toughness and self-healing behavior (Fig. 1a). Based on this concept, "mussel-inspired" metal-coordinated hydrogels were recently synthesized. This project will expand upon this basic design by generating hierarchically structured self-healing biomaterials with triggered self-assembly and well-defined mechanical properties.

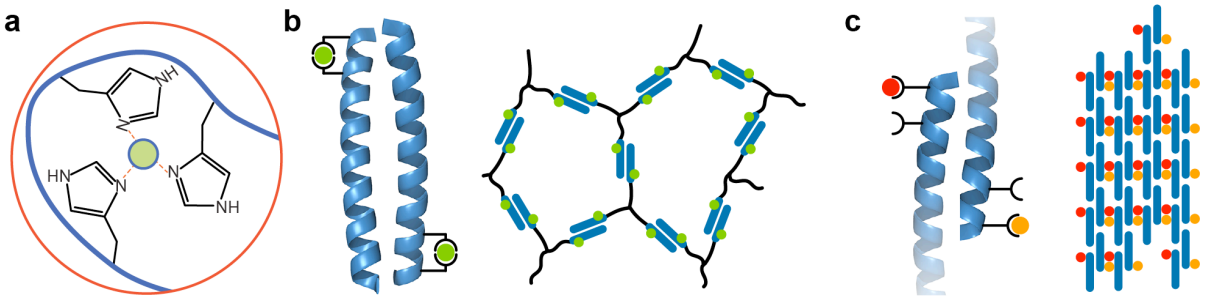

Figure 1. Metal-coordinated coiled coil (CC) based materials. a) Histidine-metal coordination bond. b) Material assembly using CC polymer conjugates. The CC termini carry metal coordination bonds for mechanical stabilization. c) Metal coordination bonds form between different CC units with 'sticky' ends.

In this project, you will bio-engineer metal binding coiled-coil (CC) peptide sequences that will self-assemble into hierarchically structured biomaterials with tunable self-healing properties (Fig. 1). By strategically and systematically altering the peptide sequence to insert metal-binding histidine residues and varying the metal ion, you will tune the mechanical stability of the CCs and introduce the capacity for strong, yet reversible lateral interactions. Towards this goal, you will test different material assembly strategies utilizing intramolecular (Fig. 1b) or intermolecular metal coordination (Fig. 1c). Besides material synthesis, you will characterize these materials (bio)chemically, structurally and mechanically using a range of analytical techniques including various spectroscopy methods (Raman, FT-IR, CD), X-ray diffraction, AFM force spectroscopy and rheology. Your results will contribute to the fundamental understanding of natural hierarchically structured biomaterials and provide design principles for man-made self-healing materials with tunable mechanical properties.

Required background: You should have a background in experimental biophysics or physical chemistry. Experience with mechanical characterization techniques will be an advantage.
Paper to read before the interview: Degtyar et al. (2014) Mechanical role of metal ions in biogenic protein-based materials. **Angewandte Chemie** 53, 12026-12044.
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