UNIVERSITÄT SALZBURG

DEPARTMENT OF CHEMISTRY AND PHYSICS OF MATERIALS

ANNOUNCEMENT

Vortragsankündigung

Mittwoch, 18. November 2026, 10.15 Uhr im SR I

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"Sustainable, multifunctional, and tough DNA hydrogels based on metal-coordination networks"

Biopolymer-based hydrogels are promising renewable materials for applications ranging from biomedical engineering to adaptive soft devices. However, the network structures and properties accessible from a given biopolymer are often constrained by its intrinsic chemical structure and the preparation method employed. Expanding these properties generally requires covalent modification or synthetic organic crosslinkers, which can compromise biodegradability and complicate material recovery.

In this study, we use naturally occurring, biomass-derived DNA as a multidentate macromolecular ligand for metal ions. Simply adding water-soluble metal salts to highly concentrated aqueous DNA solutions produces a broad family of metal–DNA hydrogels without covalent modification of DNA or the use of synthetic organic crosslinkers. Because metal ions differ in their preferred coordination sites and ligand-substitution kinetics, changing only the metal ion enables substantial control over network architecture, mechanical behavior, and adaptive function.

Pt(II) and Cu(II) were selected as representative metal ions that generate contrasting material states. Pt(II) preferentially interacts with nucleobase donor sites and produces a proposed "rod-and-rope" entangled network. The resulting Pt–DNA hydrogel withstands compressive stresses exceeding 8 MPa and recovers its macroscopic shape after unloading from 95% compressive strain, placing its compressive performance among the highest reported for predominantly bio-based hydrogels. In contrast, Cu(II) interacts mainly with phosphate groups and forms a dynamically reconfigurable bundled network. The Cu–DNA hydrogel consequently exhibits self-healing and plastic deformation.

The hydrogels can be enzymatically degraded, releasing the incorporated metal ions into aqueous solution. These results demonstrate that metal-ion selection provides a simple means of generating mechanically distinct and multifunctional hydrogels from a common, unmodified biopolymer scaffold. This approach offers a versatile platform for designing sustainable materials for biomedical applications, adaptive soft devices, and customizable three-dimensional constructs.