Title: **Building Enzyme-Like Function with Soft Polymeric Nanoparticles**

Single-chain polymer nanoparticles (SCNPs) constitute a unique class of soft polymeric nanoparticles generated by the intramolecular folding of individual synthetic polymer chains. Unlike conventional polymer nanoparticles assembled from many chains, SCNPs are unimolecular nano-objects whose defining feature is self-generated confinement. Folding restricts conformational degrees of freedom and creates heterogeneous internal nanodomains (local "pockets") connected by more flexible segments. This internal compartmentalization provides a practical route to mimic key features of biological macromolecules, positioning SCNPs as artificial enzyme-like systems and soft nanoreactors in which function emerges from confinement, microenvironment, and polymer dynamics [1].

In this lecture, SCNPs will be introduced as artificial enzyme-like systems and polymeric nanoreactors for catalysis, as well as soft nanoparticles capable of interacting with membranes and interfaces. In catalytic applications, intramolecular confinement within SCNPs enables the localization and isolation of active sites, promotes local substrate enrichment, and modulates the immediate chemical environment around the catalyst. These characteristics lead to enzyme-mimetic behavior, such as enhanced activity and selectivity, which can be tuned by polymer composition, folding degree, and the distribution of functional groups along the chain [2, 3].

Beyond catalysis, the soft nature of SCNPs plays a central role in their interaction with membranes and other confining environments. External confinement, imposed by interfaces, crowded media, or lipid bilayers, can significantly modify the size, shape, and internal organization of SCNP, thereby coupling structure, dynamics, and function. This interplay between internal and external confinement governs membrane adsorption, insertion, and perturbation, linking polymer architecture and mechanics directly to transport and interfacial behavior [4].

Overall, the talk will present SCNPs as a versatile platform of polymeric nanoparticles whose properties can be rationally modified through confinement-driven design principles to introduce adaptive behavior. By tuning polymer composition, folding, and internal organization, SCNPs can be engineered to operate under different environments, enabling their use either as enzyme-like nanoreactors for catalysis or as soft nanoparticles capable of interacting with membranes and other interfaces.

References:

[1] E. Verde-Sesto *et al.*; *Mater. Horiz.*, 2020, 7, 2292. [2] A. Blázquez-Martín *et al.*; *Angew. Chem. Int. Ed.*, 2023, 62, e202313502. [3] Mundsinger, K. *et al.*, *Angew. Chem. Int. Ed.*, 2024, 63, e202311734. [4] Y. Guo *et al.*, Macromolecules, 2019, 52, 9578.

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