

Thermal Nanomechanical Motion in Supramolecular Machinery Driving Catalytic Transformations

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With nanomechanical motion we achieve directed conformational transmission over 1 – 3 nm. What are the challenges in establishing control of catalysis via motion in supramolecular multicomponent systems? Since the latter are held together by weak interactions, it is a nontrivial task to implement robust, reproducible and reversible nanomechanical motion that drives catalysis either by liberation of catalyst or reduction of product inhibition.

It is the initial purpose of this talk to illustrate the potential of self-sorting (either single or multiple) to build catalytic machinery in motion [1a]. While these examples may be considered primitive and operationally highly restricted in comparison to the state of art in nature, e.g. the ATP synthase, they shed light on a neglected key concept: nanomechanical motion allows liberation of catalyst or reduction of product inhibition! Since the motional speed may additionally be regulated by brake stones or remote allosteric effects, one can finetune the rate of catalysis at will. By this way, one is able to even build rotating catalytic machines (= rotors) that catalyze the formation of new catalytic machinery in motion, in principle a first step toward the evolution of molecular machinery [1b].

Further examples will show multiple reversible self-sorting processes with up to 12 different components, which serve as an information system for the reversible ON-OFF regulation of catalysis and molecular logic [2,3]. Driving such systems under dissipative non-equilibrium conditions opens fascinating venues for encoding information by frequency [4].

The latest developments in our group describe the synchronization of motion in systems with two seemingly unrelated sliders-on-deck. The coupling of the motion [5] is not only based on a spectacular mechanism, but solely through the coupling the double-slider system acts as catalytic machinery that smoothly controls the action of two different catalytic transformations in a multistep catalytic cascade.

Selected References

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