The Belousov-Zhabotinsky reaction as an engine for the directed transportation of macroscopic particles on surfaces

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Oscillating chemical reactions such as the Belousov-Zhabotinsky reaction (BZR) generate macroscopic dissipative structures that can drive directional processes.[1] The question is how we can use the propagating reaction waves to convert chemical in mechanical energy. Realizing this energy conversion is a fundamental step to study the potential of non-equilibrium reactions.

If one performs the BZR in a thin layer of homogeneous solution, ring-like patterns spread in a wave-like manner through the solution. The patterns are visible due to color changes of the redox catalyst.[2] Catalysts for the BZR are iron and ruthenium complexes, which alternate in their charge state from wave to wave. We immobilized such a catalyst in a self-assembled monolayer on a silicon surface through different strategies, whose success was monitored by AFM and XPS measurements. The alternating charge states of the catalyst during the BZR and the corresponding differently strong Coulomb forces should be usable to transport a macroscopic anionic particle along with the propagating waves on a surface. Thus, the formation of dissipative structures in a non-equilibrium system is used to perform work.[3]

The anionic particles have a dendritic structure with a rotaxane core, which is functionalized with four sulfate substituted dendrons.

Transport of a macroscopic particle along a surface. The chemical wave illustrated in blue moves from the left to the right over the surface and can transport an anionic particle through Coulomb interactions. The steps a) - d) demonstrate the time-dependent transport of the particle.


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