Project 3.6 Use of external electromagnetic fields to control physicochemical processes

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Background:

Nanoscience experiences a shift from being static to dynamic, reconfigurable, and well-controllable. One manifestation of such a change is the increased importance of external stimuli for control over numerous processes. Here, we propose to employ an external electric field as a factor allowing for adjustments of physicochemical parameters. Catalysis is an example of where such an approach might be utilized.

Catalysis reactions form a major part of chemistry. It is imperative to continually study and improve them to make them more sustainable while achieving high activity and selectivity. Despite advancements in catalyst development, enzymes remain the most efficient catalysts, primarily due to their selectivity and specificity at ambient conditions. But catalysts can work in organic solvents, high temperatures and are much more stable. There is a trend to control 'chemical' catalysis by developing "catalysis-on-demand" systems (https://doi.org/10.1021/acsami.7b15253) or by engineering substrate-specificity (https://doi.org/10.1021/jacs.0c09408).

In this project, we plan to use electrostatic interactions to enforce a specific reaction pathway by improving the probability of the occurrence of the desired collisions. We have shown (https://doi.org/10.1016/j.bios.2020.112124) that pulling molecules down to a surface is possible using an electric field. If the surface has catalytic properties, applying an electric field should increase the reaction rate.

Aim:

The main goal of the project is to develop means to 1) control the conversion rates in heterogenous catalysis using an external electric field, 2) allow selective catalysis in the mixture of oppositely charged substrates, 3) control over selectivity when substrates are non-charged, but differ in electrophoretic mobility (based on the frequency of the applied electric field). Such a protocol should be coupled with proper catalyst or catalysts to demonstrate its applicability using a chain of model reactions.

Requirements:

- Master of Science (or equivalent) degree, preferably in chemistry, physics, or related fields, awarded not earlier than five years before the deadline of the current recruitment,
- ability to work independently as well as in a group,
- knowledge related to nano-science, especially from the point of view of physical chemistry,
- experience in experimental methods for materials and nanomaterials characterization,
- proficiency in English (speaking and writing)