Aspects of catalysis and electrocatalysis: materials and geometries

Julien Bachmann

Department of Chemistry and Pharmacy,
Friedrich-Alexander University Erlangen-Nürnberg

Chemical catalysis relies on the compensation of energies required to break chemical bonds with energies gained upon simultaneously making new bonds. Designing efficient catalysts is associated with understanding reaction mechanisms in which successive intermediates all have similar energies. These design rules are not limited to homogeneous (organometallic) catalysts, they also apply to the heterogeneous cases, where solid surfaces play the dominant role. For example, trends can be found in the activities of various electrod materials.

However, the chemical identity of the solid is only one facet of the coin. The morphology of the solid surface on the sub-micrometer scale plays a predominant role in determining the number of active sites in contact with the solution, on the one hand, and the transport distances between the bulk solution and the interface, on the other hand. To study those phenomena, we prepare solid surfaces with highly ordered nanostructures, the structural parameters of which are accurately controlled and systematically tuneable. We apply them to the optimization of energy conversion devices based on the surface morphology. With this, we may be able to replace expensive materials with more cost-effective ones structured in a clever manner.