

Measuring an electrocatalyst's vital signs: the need for *in operando* studies

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Batteries, fuelcells, photocells and many other applications are powered by fundamental electrochemical processes. Compared to surface science under UHV conditions, electrochemical systems combine a wide variety of additional effects. These range from the presence of an electrolyte and a multi-component environment to reaction conditions such as finite temperature, pressure, and electrode potential. Due to this complexity our knowledge of the ongoing processes is mostly limited to the macroscopic regime. However, nowadays interface-sensitive experiments together with theoretical modeling are able to provide deeper insights into structures and processes at the atomic level. This fundamental knowledge makes the development and/or design of improved (electro)catalysts possible.

Following a general overview of electrochemistry, I will compare the concepts of surface science and electrochemistry in detail, addressing both their similarities and differences. Using apparently simple electrocatalytic reactions as model systems, the effects of the reactive surrounding as well as environmental parameters will be successively explored [1,2]. It turns out that pure and perfect catalyst models, which are often used in literature, are in many cases insufficient.

Finally, these concepts will be extended from single crystals to the nanoregime, where nanostructured surfaces and particles are often used for electro-catalytic reactions. Taking transition metal alloys as an example, we will show that nanoparticles are not rigid objects but often change their morphologies and compositions under reaction conditions [3-5]. Thus, understanding the dynamic nature of these catalysts is crucial in our efforts to further extend our ability to rationally design multi-component (electro-)catalysts.

References:

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