Experimental modelling of (photo-)catalysts for challenges in the energy transition: From dilute Pd alloys to Titanium oxides and sulfides

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To overcome some of the current challenges especially in the energy transition, heterogeneous (photo)catalysis is a key technology. However, for many relevant processes, we are still lacking the optimal catalyst materials, that are cheap and available, long-term, stable and nontoxic, but very reactive and ideally selective.

In my research, the target is to develop such materials based on rational material design, also called "surface-science approach": To overcome experimental limitations under technical conditions (such as high pressures and temperatures, complex and heterogeneous multidimensional structure, dynamic catalysts, …), we investigate model systems by using well-defined (single crystal) samples under ultra-high vacuum ($< 10^{-9}$ mbar) or so-called *operando* conditions (usually few mbars). Combining insights from spectroscopy, microscopy and reactivity studies can gain a comprehensive picture on the atomic level.

In this lecture, I will briefly introduce this research concept and present few examples based on three relevant materials in view of the current energy challenges, namely a) multimetallic alloy catalysts for selective hydrogenations,[1,2] b) sulfide-based catalysts for hydrotreatments of oxygen- and nitrogen-rich biooils[3] and c) Ti-based hybrid systems for photocatalytic reactions.[4,5]

Literature:

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