9th live session of **Focus Materialchemie** – Wednesday, **28.06.2023** 16:00 – @ **Seminarraum Lehar 01** (TU-Wien, Getreidemarkt 9, BC, OG. 01, room A46) – join us on **ZOOM** (ID: 983 0066 2349)

Resolving nanoscale pattern formation in H_2 oxidation on Rh

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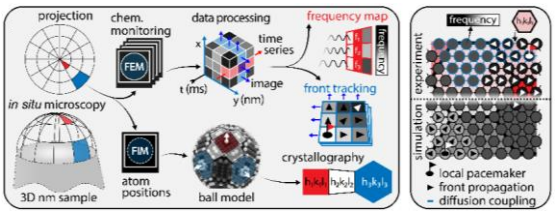
Non-linear kinetic rection behavior can induce a notable number of spatio-temporal phenomena in the form of periodic oscillations, pattern formation and even chaos. Next to the weather and biological systems such as neuronal networks, non-linear dynamics also play a crucial role in surface reactions. For their investigation using CO oxidation as a model reaction on Pt single crystal, Gerhard Ertl received the Nobel prize in 2007 [1].

In this work, we extended these studies to the nanoscale, utilizing catalytic hydrogen oxidation on Rh as model system. By field emission microscopy (FEM), we observed reaction behavior in situ and in real time, on Rh nanotip apices mimicking catalytic nanoparticles [2]. The FEM video material was evaluated using a newly developed toolbox of analysis methods, allowing the determination of local oscillation frequencies, spatial correlation, reaction front propagation and pacemakers. Using the gathered knowledge, a set of non-linear chemical behavior ranging from synchronized monofrequential oscillations and spatially decoupled multifrequential oscillations to rhythmic behavior and deterministic chaos could be induced on the nanoscale catalytic system by tuning the catalyst shape and the reaction conditions [3]. The experimental work was complimented by theoretical simulations using micro-kinetic modelling, which was extended to 2D coupled oscillator networks to accurately represent the observed behavior [4]. The combination of real-time nanoscale microscopy, advanced evaluation techniques and simulations made possible to reveal the role of surface crystallography for catalytic functionalities and understanding the importance of interaction between adjacent regions towards the full potential of the catalytic reaction.



1. G. Ertl, Reactions at Surfaces: From Atoms to Complexity (Nobel Lecture). *Angew. Chem. Int. Edit.* **47**, 3524–3535, (2008).
2. J. Zeininger, Y. Suchorski, M. Raab, S. Buhr, H. Grönbeck, G. Rupprechter, Single-Particle Catalysis: Revealing Intraparticle Pacemakers in Catalytic H_2 Oxidation on Rh. *ACS Catal.* **11**, 10020–10027, (2021).
3. M. Raab, J. Zeininger, Y. Suchorski, K. Tokuda, G. Rupprechter, Emergence of chaos in a compartmentalized catalytic reaction nanosystem. *Nat Commun* **14**, 736 (2023).
4. J. Zeininger, M. Raab, Y. Suchorski, S. Buhr, M. Stöger-Pollach, J. Bernardi, G. Rupprechter, Reaction Modes on a Single Catalytic Particle: Nanoscale Imaging and Micro-Kinetic Modeling. *ACS Catalysis* **12**, 12774 (2022).