Dynamics of catalytically active clusters under the (fast) scanning tunneling microscope

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In our group, we investigate the dynamics of catalytically active atoms and clusters at the atomic scale under harsh conditions – elevated temperatures, reactive gas environments, and electrolytes under potential control. As a local probe, we employ scanning tunneling microscopy (STM), which has been upgraded with sophisticated fast tools for movie acquisition, cluster tracking, and high-speed measurements. We complement this structural characterization with integral pulsed valve molecular beam "sniffer" activity measurements at the solid-gas interface, as well as chronoamperometry at the solid-liquid interface, utilizing atomically precise clusters on highly ordered supports.

I will apply this approach to discuss three examples:

(i) Exploring the encapsulation of sub-nm clusters by a reducible oxide support and its impact on cluster stabilization and catalytic activity: $Pt_{5\leq n\leq 20}/Fe_3O_4(001)$

(ii) Investigating a reducible oxide support that is able to reversibly form and redisperse supported clusters. With $Pt_{20}/CeO_2(111)$ samples, we demonstrate how cluster dimensionality can be controlled through the surface oxidation state of the support.

(iii) Studying electrocatalytic activity on the single atom: We present first results on the oxygen reduction reaction (ORR) on iron octaethylporphyrin molecules under the fast EC-STM.