In situ and operando AFM characterization of faceted semiconductor nanoparticles for improved H-production

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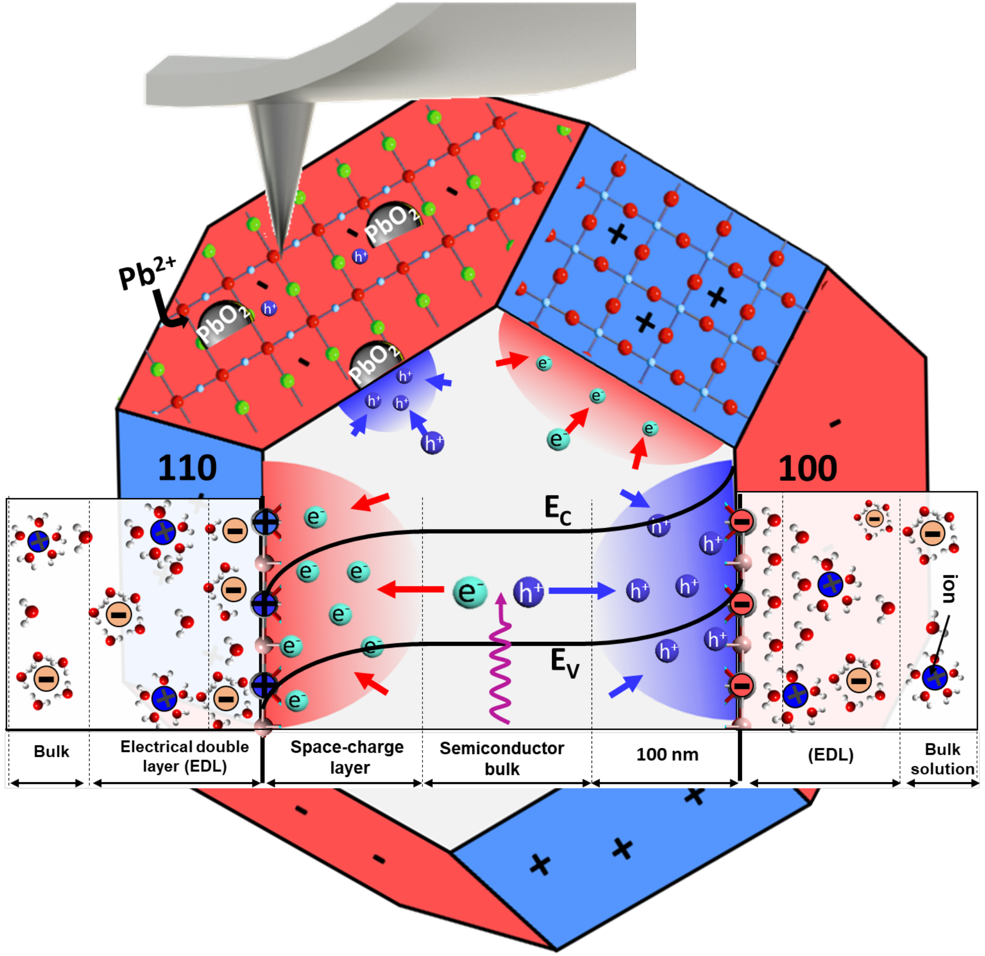
The aim of the project is to enhance the efficiency of direct semiconductor-based photocatalytic conversion of solar energy to chemical fuels. This involves understanding and optimizing processes at faceted semiconductor nanoparticle-electrolyte interfaces. Factors under consideration include nanoparticle shape, cocatalyst distribution, and local surface properties like structure, charge densities, defect distributions, and hydration effects, alongside ambient fluid composition (pH, specific ions). By employing AFM-based methods, with a particular focus on atomic resolution imaging, surface charge mapping, and facet-dependent photocatalytic activity under operando conditions, the project seeks to identify factors influencing electron-hole pair separation and transfer efficiency in photocatalytic systems. Ultimately, the aim is to establish the groundwork for the methodical development of more efficient photocatalytic materials and operating conditions.

AM-AFM & AFM-SECM in liquid

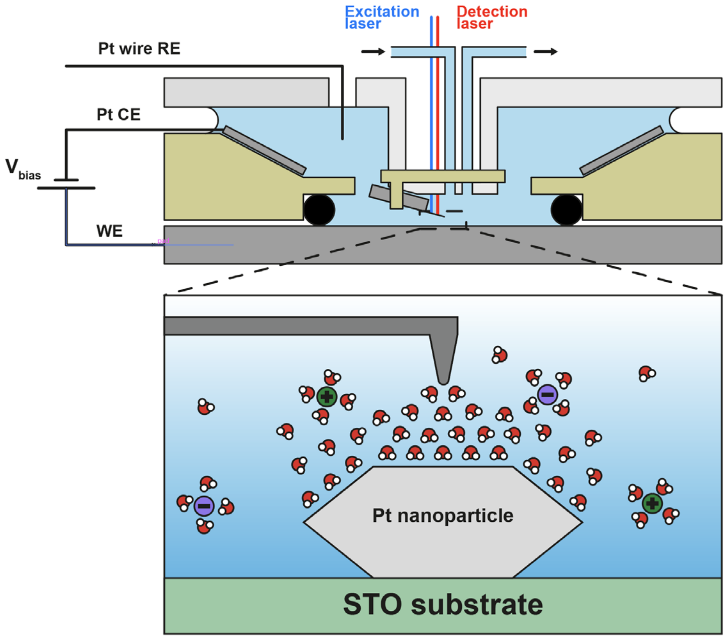


In situ AFM characterization of platinum (nano)catalysts for water electrolysis

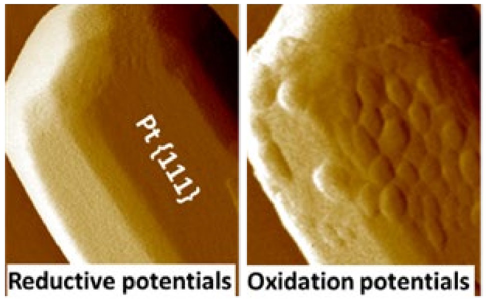
Collaborators:

- **Igor Siretanu and Frieder Mugele, Physics of Complex Fluids**
- **Marco Altomare and Guido Mul, Photocatalytic Synthesis**

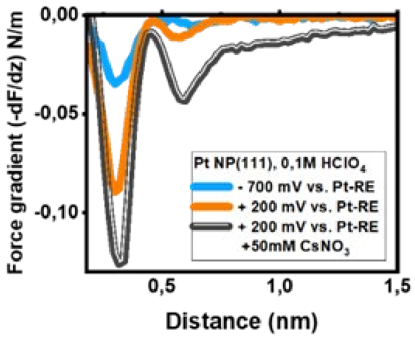
The project aims to address challenges in the hydrogen evolution reaction and hydrogen oxidation reaction, which are crucial for the renewable hydrogen economy. Currently, there is a significant decrease in reaction kinetics when transitioning from acid to alkaline environments, hindering the development of electrochemical energy technologies. The project seeks to elucidate the underlying mechanisms causing this sluggishness, focusing on the role of surface charge, electric double layer structure, and interfacial hydration layers in electrocatalysis. By extending the dual-scale Atomic Force Microscopy (ds-AFM) method to operando conditions for faceted platinum electrocatalyst nanoparticles, the project aims to uncover insights into how changes in fluid composition and applied potential affect local surface properties. Ultimately, the goal is to optimize hydrogen evolution reactions at platinum electrocatalysts, contributing to the engineering of materials, electrolytes, and operation protocols for stable catalysts with improved efficiency and stability.



Surf. reconstruction

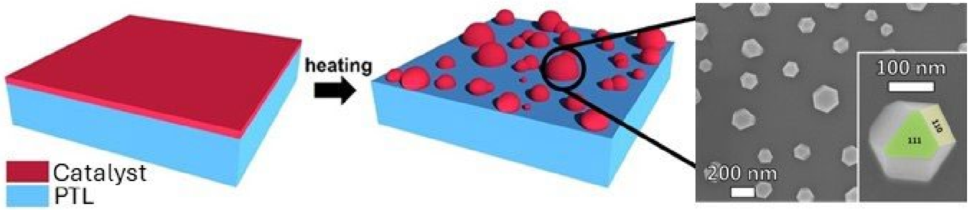


Hydration

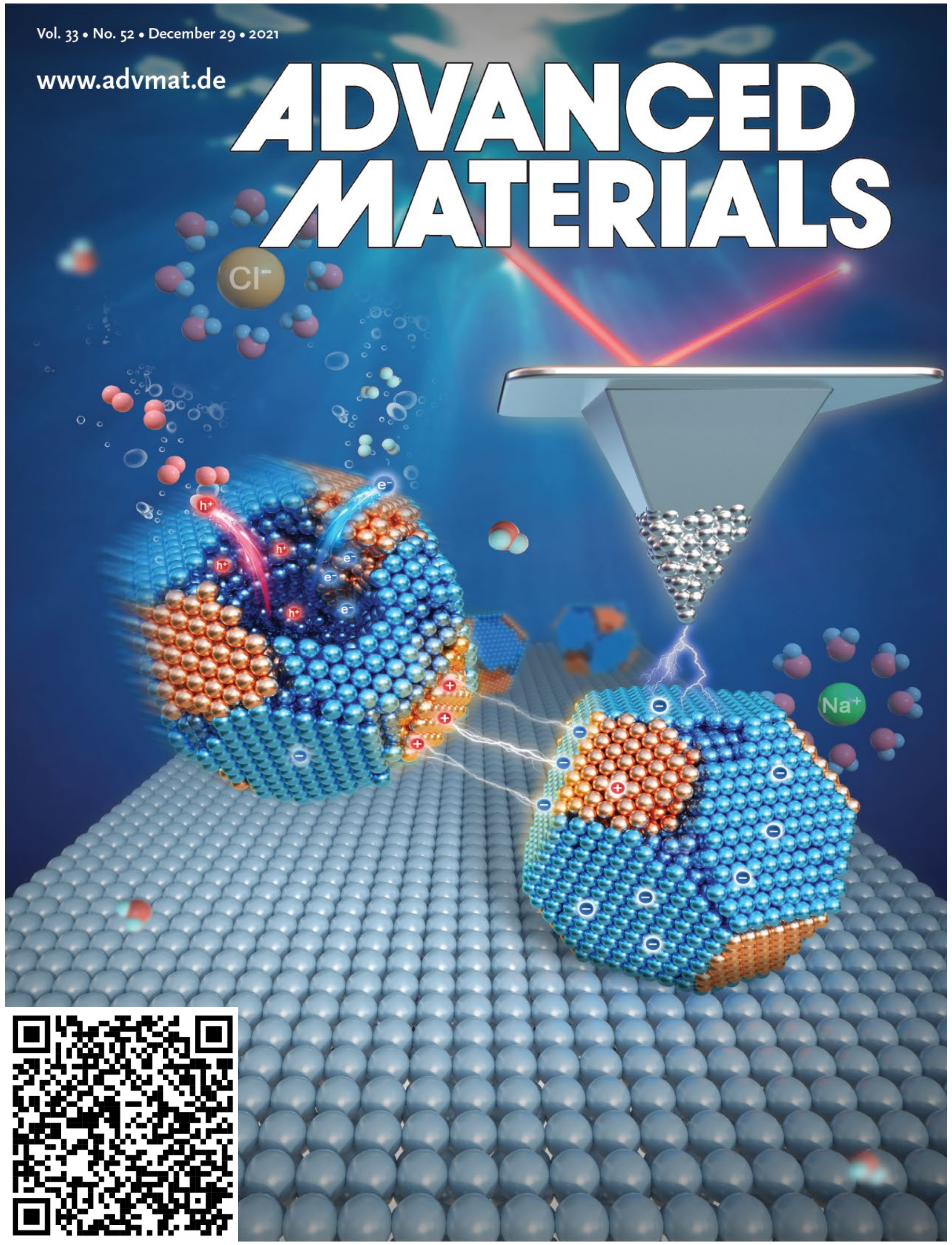


Sputtering & Solid-state dewetting

Highly facetted NPs



Pictures and/or videos of the project(s) work



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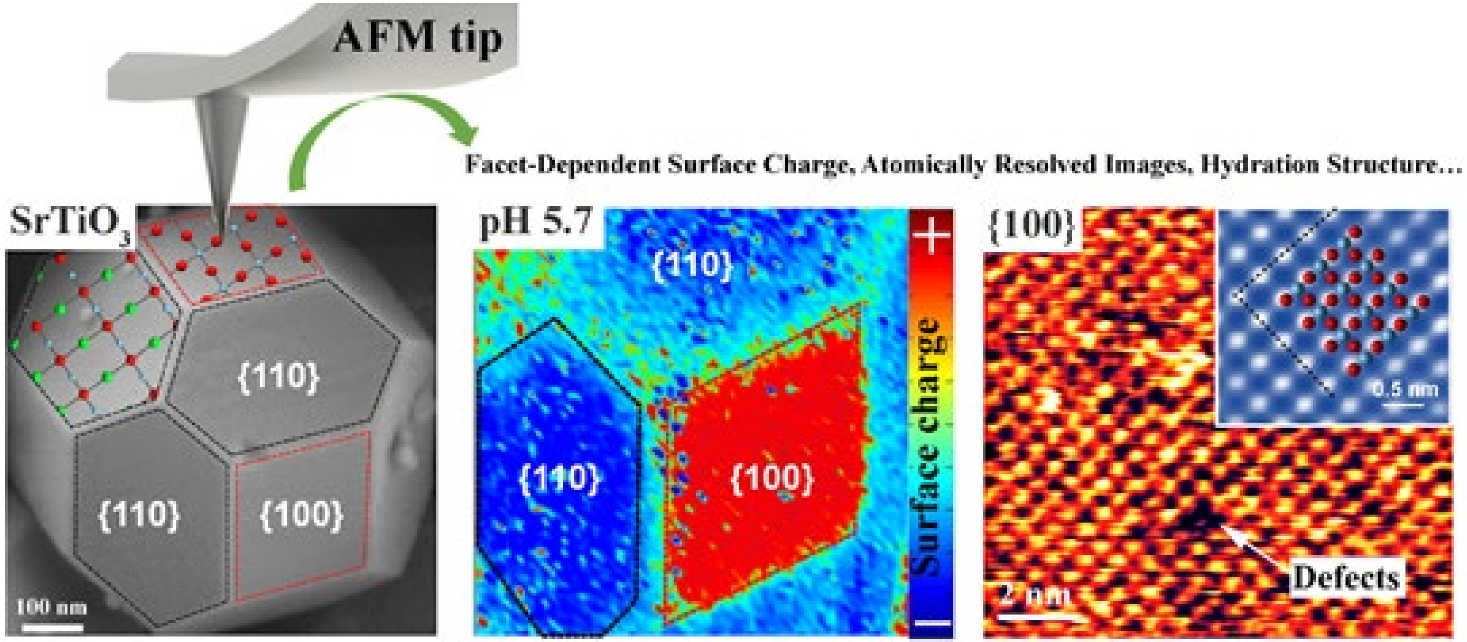

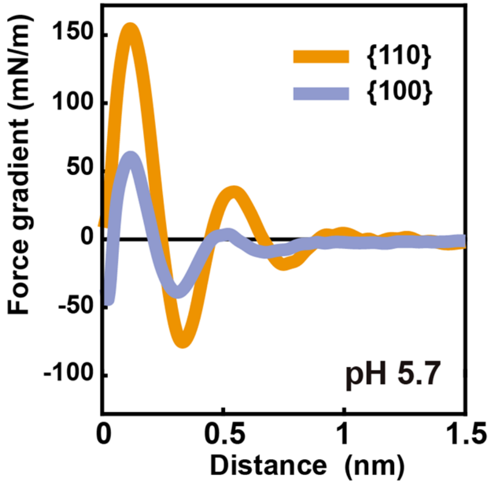

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