Department of Physics
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PHYSICS COLLOQUIUM

Speaker: Dr. Herbert Over, Justus Liebig University, Giessen, Germany

Acidic Water Electrolysis for Green Hydrogen Production: Surface Science Approach to Anodic Corrosion

Friday, February 21, 2025, 1:30 pm, PSB 160/161

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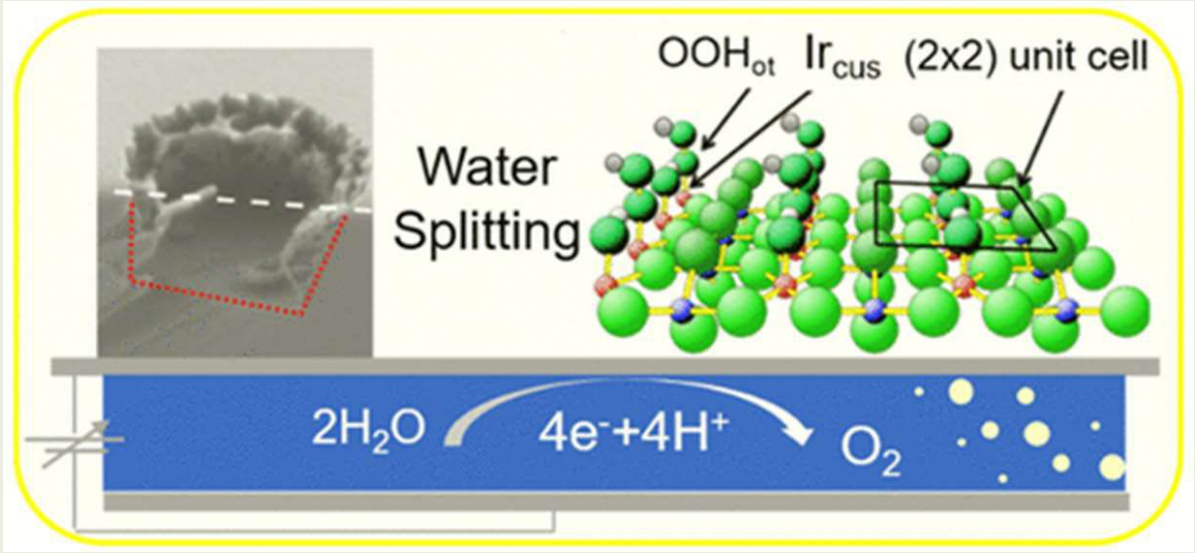
Abstract: A major challenge for renewable energy sources such as wind, solar and tidal is their intermittent availability and the need to store excess energy during periods of high supply. Water electrolysis is expected to become a cornerstone of sustainable energy conversion from renewable electrical energy to molecular hydrogen. At present, however, only acid water electrolyzers with polymer electrolyte membranes (PEM) are able to cope with such dynamic operating conditions, with the unavoidable trade-off that the anode catalyst used is made of noble metal oxides based on IrO2 and RuO2. **[1]** IrO2 is much less active than RuO2, but the stability of IrO2 is much higher than that of RuO2, making it the current benchmark for PEM water electrolyzers.



In this talk, I will discuss fundamental studies based on single-crystal model electrodes that can help to understand anodic corrosion processes at the microscopic level and pave the way for a rational search for substitutes for scarce and expensive iridium and ruthenium. Single crystalline IrO2(110) films have been shown to be extraordinarily stable under highly anodic conditions **[2,3]**, while single crystalline RuO2(110) is prone to dissolution, which has been shown to be sensitive to strain. **[4]** I will discuss a theoretical molecular model for the dissolution of RuO2, in which backside attack (a type of Walden inversion) is identified with the key elementary step in the anodic corrosion process to break Ru-O structural backbonds to the surface. **[5]**

[1] Herbert Over, *ACS Catal.* **2021**, *11,* 8848.

[2] Tim Weber et al. *ACS Catal.* 2019, **9**, 6530.

[3] Tim Weber et al. *ACS Catal.* 2021, **11**, 12651

[4] P. Chadhary et al. *ChemElectroChem* **2024**, *11*, e202300659.

[4] Franziska Hess, Herbert Over, *ACS Catal.* **2023**, *13*, 1395.

BIO: Prof. Herbert Over graduated from Free University Berlin with a PhD in Chemistry. After a postdoc at University of Wisconsin, Milwaukee, he joined the Fritz Haber Institute in Berlin where he served as a Group Leader in Noble Laureate Gerhard Ertl's department of Physical Chemistry. He joined Justus-Liebig University, Giessen, in 2002 as a Professor in Physical Chemistry. His research focuses on understanding fundamental processes in chemical reactions through the development and implementation of surface science as well as in situ methods for both thermal and electrochemical processes.