NUS National University of Singapore | Department of Materials Science & Engineering
College of Design and Engineering

Department Seminar

Dear Colleagues & Students,
You are cordially invited to a special seminar on
Date: 24 September 2026, Thursday
Time: 15:00 - 16:30
Venue: EA-06-02, CDE, NUS (Map)

Dynamic Electrochemical Interfaces: From Understanding to Controlling Reactivity

By Prof. Antonia Herzog
Department of Chemistry, Technical University of Denmark (DTU), 2800 Kongens Lyngby, Denmark

Hosted by Asst. Prof. Xianbiao Fu

Abstract:
Electrochemical processes powered by renewable energy offer promising pathways for sustainable chemical production from abundant feedstocks such as carbon dioxide and nitrogen. However, achieving high selectivity, activity, and stability remains challenging, in part because catalyst–electrolyte interfaces are inherently dynamic. Catalyst structure, surface composition, adsorbates, and interphases can continuously evolve under reaction conditions, making their characterization and control essential for directing reactivity [1].

In this talk, I will discuss how operando spectroscopy can reveal these dynamic working states and guide strategies to control them. For CO2 reduction on Cu-based catalysts, time-resolved operando Raman and X-ray absorption spectroscopy reveal relationships between catalyst composition, adsorbed intermediates, and multicarbon product formation [2-5]. Furthermore, potential pulsing provides a means to deliberately manipulate interfacial states and steer selectivity toward products such as ethanol. I will then extend this concept to lithium-mediated nitrogen reduction, where operando Raman spectroscopy reveals the evolution of the solid-electrolyte interphase and its role in controlling nitrogen activation and competing hydrogen evolution [6-7].

Building on these insights, I will introduce emerging research directions from our group toward the design of dynamically controlled and hybrid catalytic interfaces for selective electrosynthesis. By integrating catalyst and electrolyte design with time-dependent electrochemical operation and operando molecular characterization, we aim to control reaction sequences and enable increasingly complex transformations, including the formation of new carbon–carbon and carbon–heteroatom bonds from abundant molecular feedstocks.

[1] Sebastián-Pascual, Herzog, Zhang, Shao-Horn, Escudero-Escribano, ***Nat. Catal.*** 8, 986 (2025).
[2] Herzog, Bergmann, Roldan Cuenya et al. ***Angew. Chem. Int. Ed.*** 60, 74264 (2021).
[3] Herzog, Bergmann, Roldan Cuenya et al. ***Nat. Comm.*** 15, 3986 (2024).
[4] Timoshenko, Herzog, Magnussen, Roldan Cuenya et al. ***Nat. Catal.*** 5, 259 (2022).
[5] Herzog, Rüscher, Bergmann, Roldan Cuenya et al. ***Energy Environ. Sci.*** 17, 7081 (2024).
[6] Iriawan, Herzog, Yu, Ceribelli, Shao-Horn, ***ACS Energy Lett.*** 9, 4883 (2024).
[7] Herzog, Iriawan, Ah, Shao-Horn, ***Nat. Catal.*** 9, 711 (2026).

Biography:

Dr. Antonia Herzog is a Tenure-Track Assistant Professor in the Department of Chemistry at the Technical University of Denmark (DTU). She received her Ph.D. from the Fritz Haber Institute of the Max Planck Society, conducting her doctoral research with Prof. Beatriz Roldan Cuenya, and subsequently joined Prof. Yang Shao-Horn's group at MIT as a postdoctoral researcher. Her research focuses on electrocatalysis, sustainable electrosynthesis, and operando spectroscopy. She has published more than 30 peer-reviewed articles and has received several distinctions, including the First Prize of the Tiburtius Prize for the best doctoral dissertations across Berlin universities, a Villum Young Investigator Grant, and an Novo Nordisk Foundation Starting Package Grant. She is also a member of the Young Academy of Technology, Science and Innovation (YATSI) and serves on the board of the Danish Electrochemical Society (DES).

Looking forward to seeing all of you!