76th Annual Meeting

of the International Society of Electrochemistry

7 - 12 September 2025

Mainz, Germany

PROGRAM

https://annual76.ise-online.org

e-mail: events@ise-online.org

Lessons from Bioelectrochemistry: Enzymes, Bio-Batteries, and the Electrochemical Path to Decarbonization

Frank. N. Crespilho
University of Sao Paulo, Brazil
https://bioelectrochemistry.iqsc.usp.br
frankcrespilho@iqsc.usp.br

Why is bioelectrochemistry suddenly at the forefront of scientific innovation? What compels researchers across disciplines to converge at the interface between biological systems and electrochemical principles? This keynote explores these questions by highlighting how bioelectrochemistry is uniquely positioned to address major global challenges in sustainable energy conversion, green catalysis, and decarbonization strategies. Recent advances will be presented, focusing on the role of natural and engineered enzymes in electrocatalytic systems for CO_2 reduction and hydrogen production[1,2]. Particular attention will be given to the reconstitution of apoenzymes with tailored metal centers[2] to enhance redox reactivity, as well as biofilm-based systems that facilitate long-range electron transfer. The application of in situ and operando techniques[3,4,5]—such as X-ray absorption nanospectroelectrochemistry[4]—will be discussed as powerful tools for probing catalytic dynamics under working conditions. The talk will also address emerging bio-battery technologies[6] and eco-friendly energy storage platforms[7] that integrate bioinspired materials and processes to deliver safe, scalable, and sustainable solutions. Taken together, these topics demonstrate how bioelectrochemistry is evolving from a fundamental discipline into a technological enabler, offering a versatile framework to guide the development of clean energy systems and synthetic bioelectrocatalytic platforms.

References

1. Sedenho, G. C.; Colombo, R. N. P.; Crespilho, F. N. *Insights from Enzymatic Catalysis: A Path Toward Bioinspired High-Performance Electrocatalysts.* ChemCatChem, 15, e202300491, 2023.
2. Iost, R. M.; Radhakrishnan, V.; Nascimento, S. Q.; Lima, F. H. B.; Crespilho, F. N. *Hydrogen Bioelectrogeneration with pH-Resilient Oxygen-Tolerant Cobalt Apoenzyme-Saccharide.* Chemical Communications, 60, 2509-2511, 2024.
3. Macedo, L. J. A.; Hassan, A.; Sedenho, G. C.; Crespilho, F. N. *Assessing electron transfer reactions and catalysis in multicopper oxidases with operando X-ray absorption spectroscopy*. Nature Communications 11, 316, 2020.
4. Sedenho, G. C.; Neckel, I. T.; Colombo, R. N. P.; Pacheco, J. C.; Bertaglia, T.; Crespilho, F. N. *Investigation of Water Splitting Reaction by a Multicopper Oxidase through X-ray Absorption Nanospectroelectrochemistry*. Advanced Energy Materials, 12, 47, 2202485, 2022
5. Sedenho, G. C.; Hassan, A.; Souza, J. C. P.; Crespilho, F. N. *In Situ Operando Electrochemistry of Redox Enzymes.* Current Opinion in Electrochemistry, 34, 101015, 2022.
6. Crespilho, F. N.; Pereira-Brito, R.; Policia, R.; Pereira, N.; Sedenho, G. C.; Costa, C. M.; Lanceros-Mendez, S. *Yeast Bio-battery.* Sustainable Energy & Fuels, 8, 5165-5169, 2024.
7. Bertaglia, T.; Costa, C. M.; Lanceros-Méndez, S.; Crespilho, F. N. *Eco-Friendly, Sustainable, and Safe Energy Storage: A Nature-Inspired Materials Paradigm Shift.* Materials Advances, 5, 7534-7547, 2024.