

Engineering Porous Electrode Materials Across Length Scales

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Venue: Cheung On Tak Lecture Theater (LT-E),
Academic Building, HKUST, [\(Location\)](#)

Abstract

Carbonaceous electrodes are central to a wide range of electrochemical energy technologies – including flow batteries, fuel cells, and metal–air batteries – where they serve either as the active surface for electrochemical reactions or as supports for noble metal electrocatalysts. Their three-dimensional microstructure (porosity, surface area, pore size distribution, and connectivity) and surface chemistry (functional groups, wettability, charge density, and polarity) play a critical role in governing device performance, durability, and system-level efficiency.

In this lecture, I will discuss a selection of fundamental challenges in electrochemical science and engineering in which porous electrodes are key enablers. I will highlight both commonalities and contrasts in electrode property requirements between single-phase systems, such as redox flow batteries, and multiphase systems, such as polymer electrolyte fuel cells. First, I will present computational strategies for the rational design of porous electrodes for flow batteries, alongside scalable synthetic platforms for manufacturing carbonaceous electrodes with tailored microstructures. Second, I will demonstrate how precise control of surface chemistry through chemical grafting, electrografting, and electropolymerization can be leveraged to tune wettability, reaction kinetics, and selectivity. Finally, I will focus on catalyst layers in polymer electrolyte fuel cells, illustrating how the interplay between support microstructure and surface chemistry governs proton transport, mass transfer, and overall fuel cell performance.

About the Speaker



Prof. Antoni Forner-Cuenca earned his Chemical Engineering degree from the University of Alicante (2013) and completed his PhD at the Paul Scherrer Institute and ETH Zurich (Switzerland), where he pioneered gas diffusion layers with patterned wettability for polymer electrolyte fuel cells. His doctoral work, completed in 2016, was recognized with the ETH Zurich Medal for outstanding thesis and the Electrochemical Society Energy Technology Graduate Student Award. From 2017 to 2018, he was a postdoctoral fellow at the Massachusetts Institute of Technology, advancing the science and engineering of redox flow batteries for large-scale energy storage. In 2019, Prof. Forner-Cuenca started his independent career at Eindhoven University of Technology, where he founded and leads the Electrochemical Materials and Systems Group. He was promoted to Associate Professor in 2023 and to Full Professor in late 2025.

His research has been distinguished with numerous honors, including the Princess of Girona Award, the Royal Netherlands Academy of Arts and Sciences Early Career Award, the Electrochemical Society Energy Technology Division Supramaniam Srinivasan Early Career Award, an ERC Starting Grant, Dutch Science Foundation (NWO) Veni and Vidi Grants, and the Hydrogen Europe Young Scientist Award. He was also voted Best Teacher of the TU/e master's program for three academic years.

Prof. Forner-Cuenca's research focuses on advancing transformative electrochemical technologies for real-world energy applications. By leveraging principles from (electro)chemical engineering, materials science, and physical chemistry, his team designs, synthesizes, characterizes, and models innovative materials and electrochemical reactors. Key applications include large-scale energy storage with flow batteries, energy conversion via hydrogen fuel cells and electrolyzers, and decarbonization of the chemical industry through efficient molecular synthesis and separation processes.

All are welcome