Hydrogen Economy in the US and the Electrochemical Energy Research at UC Merced

Po-Ya Abel Chuang, Associate Professor
Mechanical Engineering, University of California Merced, USA
Email: Abel.chuang@ucmerced.edu

In this seminar, I will begin with a brief introduction to my background and UC Merced, the newest campus in the University of California system, which has rapidly grown in research excellence and was recently designated as an R1 university, recognizing its high research activity. I will then introduce hydrogen and fuel cell technologies in the United States, covering both high-temperature and low-temperature applications. This discussion will include an overview of key national initiatives, such as the Million Mile Fuel Cell Truck (M2FCT) consortium, a Department of Energy (DOE)-funded initiative focused on advancing proton exchange membrane fuel cells to achieve 2.5 kW/g power density and 30,000-hour durability by 2030 for heavy-duty trucks (millionmilefuelcelltruck.org); the H2New consortium, a DOE initiative aiming to develop affordable, reliable, and efficient large-scale electrolyzers to produce low-cost clean hydrogen (h2new.energy.gov); and the recently established CO2 Reduction and Upgrading for e-Fuels (CO2RUe) consortium, which focuses on developing advanced technologies to convert waste CO2 into climate-friendly e-fuels using renewable electricity (energy.gov/eere/co2rue). Additionally, I will introduce California's hydrogen hub initiative, ARCHES H2, a collaborative effort to accelerate renewable hydrogen projects and infrastructure, supporting the state's transition to a zero-carbon economy (archesh2.org).

Following this broader context, I will present an overview of our research activities at UC Merced's TEEL laboratory (teel.ucmerced.edu). Our work spans four key areas: (1) catalyst material synthesis and development, including electrocatalysts for low-temperature oxygen evolution (OER), oxygen reduction (ORR), hydrogen evolution (HER), hydrogen oxidation (HOR), and CO2 reduction (CO2RR); (2) membrane electrode assembly (MEA) integration, covering coating techniques, decal transfer methods, catalyst-coated membrane fabrication, and gas diffusion electrode development; (3) diagnostics tool development, including rheo-impedance studies of catalyst inks, neutron radiography for water transport in electrochemical cells, and limiting current measurements for oxygen transport in fuel cells; and (4) performance evaluation and mathematical modeling, leveraging techniques such as electrochemical impedance spectroscopy (EIS) and distributed time relaxation (DRT) analysis.

I will conclude the seminar with a brief introduction to my laboratory members, highlighting their contributions to our research efforts.

References:

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3. Mehrazi, Shirin, et al. "A rheological approach to studying process-induced structural evolution of the microporous layer in a proton exchange membrane fuel cell." Electrochimica Acta 389 (2021): 138690.