Department of Materials Science and Engineering Seminar Series 2025

REDOX-MEDIATED METAL-AIR FUEL CELLS WITH ENHANCED OPERATIONAL FLEXIBILITY FOR DURABLE POWER GENERATION

SONG YUXI

Date and time: Dec. 2 (Tue), 2-5pm

Venue: E2-03-32

Abstract

Overreliance on fossil fuels has led to energy depletion and climate change, with global temperatures rising 1.5 °C since the pre-industrial era. Renewable sources such as solar and wind are promising but face intermittency and geographic limitations, complicating demand-driven electricity supply. Aqueous metal–air batteries, using ambient oxygen as the cathode reactant and abundant metals as the anode, provide high energy density and safety but are constrained by sluggish reaction kinetics, low metal utilization, electrode passivation, and operational limitations.

This thesis explores redox-mediated strategies to address these challenges across Zn-, Al-, and Fe-air systems. By employing redox mediators, the metal oxidation reaction is liberated from the electrode to a separated fuel tank, decoupling energy storage from power generation and enabling convenient fuel refilling and product removal. In addition, the fast reaction kinetics of the mediators, compared to the direct metal oxidation on the electrode, allow the cell to operate at high power and current densities while suppressing parasitic hydrogen evolution reactions and achieving high metal utilization. Overall, this work establishes redox-mediated metal-air fuel cells as a versatile, high-performance, and sustainable platform for long-duration, large-scale energy storage and power generation.

Biography

Song Yuxi received her bachelor's degree from Xihua University in 2017 and her master's degree from Chongqing University in 2020. She is currently a Ph.D. candidate in the Department of Materials Science and Engineering at the National University of Singapore under the supervision of Prof. Wang Qing. Her research focuses on the redox-mediated metal-air fuel cells for durable power generation, spanning Zn-, Al-, and Fe-air systems. The aim is to establish redox mediation as a general strategy to overcome kinetic barriers, passivation challenges, and metal-utilization limitations across diverse metal–air chemistries.

Please join us!

HOST: Asst. Prof Jing Yan