Department of Materials Science and Engineering Seminar Series 2026

Understanding Anisotropic Catalytic Interfaces by Operando Functional Imaging

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Date and time: November 17, 2026, 3:00 p.m.

Venue: EA-06-05

Abstract

Catalytic performance depends on local surface chemistry and dynamics that are often obscured by ensemble-averaged measurements. This thesis combines operando single-molecule fluorescence imaging with scanning probe microscopy and spectroscopy to investigate chemistry associated with surface-bound hydrogen (H*), catalytic-state dynamics and spatial communication at anisotropic Cu-based interfaces.

On Cu_2O particles, dry-state photovoltage measurements indicate a tendency toward greater electron accumulation on {100}, whereas operando imaging reveals higher H*-associated activity on {111}. Correlated photoluminescence measurements reveal a biphasic relationship between defect-related optical states and surface hydrogen coverage. Restructuring and communication analyses further associate facet-dependent surface evolution and surface transport of H* with heterogeneous H* coverage.

The study then examines an enzyme-inspired Cu(100|111) faceted mesostructure with complementary catalytic functions. H* imaging and competition-enabled adsorption measurements support an H*-rich {111} environment for hydrogenation alongside stronger nitrate/nitrite adsorption on {100}. Restructuring analysis resolves local kinetic cooperativity, and communication analysis reveals anisotropic H* surface transport, supporting cooperative behavior across adjacent facets. Bulk electrochemistry shows improved ammonia-selective nitrate reduction relative to the Cu controls. Together, these studies connect spatial organization and interfacial dynamics to catalytic function and provide a basis for designing multifunctional heterogeneous catalysts.

Biography

Chen Shurui is a PhD candidate in the Department of Materials Science and Engineering at the National University of Singapore, supervised by Prof. Mao Xianwen. His research focuses on operando single-molecule fluorescence imaging and scanning probe microscopy to investigate local reaction activity and dynamics at catalytic interfaces.

Please join us!

HOST: Asst Prof Ahmet Avsar