UC Irvine Samueli
Department of Chemical and Biomolecular Engineering

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Development of Advanced Electrocatalysts for CO2 and CO Reduction

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Abstract: Electroreduction of CO_2 represents a promising approach toward artificial carbon recycling. Copper (Cu) has been known as the only metal that catalyzes C-C coupling in the electroreduction of CO_2 and CO toward value-added C_{2+} hydrocarbon products such as ethylene, ethanol, acetate and n-propanol. To achieve electrocatalytic performance super to pure Cu, extensive efforts have been devoted to alloy or single-atom electrocatalysts for CO_2 and CO reduction, but how atomic ensembles of active sites interplay with the C-C coupling mechanisms remains largely elusive. This presentation aims to introduce our efforts on the development of advanced alloy electrocatalysts for CO_2 and CO reduction. Topics to be covered include i) alloy electrocatalysts such as Pd_n@Au and random Pd-Cu bimetallics and ii) single-atom Cu1@C_3N_4 for CO_2 or CO reduction to C_2 hydrocarbons. Atomic structures of these electrocatalysts are characterized by using state-of-the-art electron microscopy and X-ray spectroscopy techniques. Surface structures and adsorption properties of the electrocatalysts are probed by measuring temperature- or potential-programed chemisorption of small molecules (e.g., CO_{ad} and OH_{ad}). Kinetic analysis is performed to discern the rate-determining factors and reaction pathways. The established structure-property-performance correlations are further subjected to computational simulations to develop fundamental understanding of the catalytic mechanisms. Our work highlights the great potential of utilizing CO_2 as the feedstock for renewable synthesis of hydrocarbon chemicals.

Bio: Dr. Chao Wang is an associate professor of chemical and biomolecular engineering and the director of the Nano Energy Laboratory. He is also the director of master's admissions. His research interests are primarily in carbon capture and conversion, electrochemical energy conversion and storage, and heterogeneous catalysis for green chemical engineering. He received his bachelor's in 2004 from the University of Science and Technology of China, and doctorate from Brown University in 2009. Prior to joining Johns Hopkins, he was a postdoctoral fellow at Argonne National Laboratory. Dr. Wang is the recipient of AFOSR Young Investigator Award (2014) and ARO Young Investigator Award (2015). He also received the Johns Hopkins University Catalyst Award (2015) and Discovery Award (2016). He is currently serving as Advisor for AMOGY Inc. (since 2022) and Associated Editor for Science Advances (from 2023). He has co-founded two startups HighT-Tech LLC. (2018) and EDAC Labs, inc. (2022).

Hosted by: *Prof. Vojislav Stamenkovic*