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Electrocatalysis for converting carbon dioxide into valuable chemicals

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Majority of the world's energy consumption and chemical feedstock comes from fossil fuels today. As the demand for energy and consumables continues growing, affordable and feasible fossil fuel sources are however increasingly depleted. Electrochemical reduction of CO_2, an artificial way of carbon recycling, represents one promising solution for energy and chemical sustainability. With water as the reducing agent, it can generate a range of reduced carbon compounds, ranging from carbon monoxide (CO) and formic acid to methane, methanol and ethanol. These chemicals can either be directly used as fuels, such as ethanol being used to partially substitute gasoline for internal combustion engines, or be converted into liquid fuels and other valuable chemicals through further processing (e.g., Fischer-Tropsch process for CO). Despite the many advantages, electrochemical reduction of CO_2 is challenged by the absence of efficient catalysts for this reaction. Copper is the only known material capable of catalyzing CO_2 reduction at significant rates, but it still requires a large overpotential of almost 1 V in ambient conditions. Solutions to this challenge by looking into copper-alloy catalysts were explored. It is envisioned that ensemble, ligand and/or strain effects present in the alloy catalysts could alternate the reaction pathway to be more active and selective towards valuable hydrocarbon products. By combining atomically resolved characterization of the catalyst nanostructures and chromatographic analysis of the reaction products, we have been able to establish fundamental understanding of the structure-property relations of the alloy catalysts as well as mechanisms of the multi-electron pathway of CO_2 reduction.

Biography

Chao Wang completed his PhD from Brown University in 2008 and Postdoctoral training from Argonne National Laboratory in 2012. He is currently an Assistant Professor in Chemical and Biomolecular Engineering of Johns Hopkins University. He has published 40 papers in peer-reviewed journals and holds 3 patents. He is a recipient of the 2013 JHU E2SHI Award and 2014 AFOSR Young Investigator Award.

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