Synthesis of a Bifunctional Metal (Fe, Ni, Co) Phthalocyanine/Tin (IV) Oxide/Carbon Nanotube Electrocatalyst for the Aqueous CO2 Reduction to Carbon Monoxide and Formate at Different Potentials Respectively

Cohen, Jessica (School: Spackenkill High School)

Electrochemical reduction of carbon dioxide (CO2) produces useful fuels and chemicals for various commercial industries while combating climate change. The purpose of this experiment is to synthesize several catalyst materials consisting of novel metal phthalocyanine/tin oxide on carbon nanotubes. These materials serve as carbon dioxide reduction electrocatalysts developed for the purpose of being novel bifunctional catalysts to selectively produce carbon monoxide (CO) in one potential range, -1.1 V vs Ag/AgCl to -1.3 V vs Ag/AgCl, and formic acid in a more negative potential range, from -1.4 V vs Ag/AgCl to -1.6 V vs Ag/AgCl. Pure carbon nanotubes (CNT) are reacted with a tin precursor to form a relatively uniform layer of tin (IV) oxide (SnO2) on CNT. Metal phthalocyanine (MPc) molecules are then uniformly anchored on the SnO2/CNT hybrid. This process is done for iron phthalocyanine (FePc), nickel phthalocyanine (NiPc), and cobalt phthalocyanine (CoPc). The CoPc/SnO2/CNT catalyst proved to be the most active while still remaining selective with a faradaic efficiency for CO of 77.01% at -1.2 V vs Ag/AgCl and a faradaic efficiency for formic acid of 54.31% at -1.6 V vs Ag/AgCl, along with an average total current density of -6.55 mA/cm2 at -1.6 V vs Ag/AgCl. This experiment demonstrates the feasibility of a novel type of electrocatalyst that allows for the user to tune the product produced from CO2 by changing the operating potential.

Awards Won:

Fourth Award of $500