Electrification and Decarbonization of Chemical Synthesis

Chemical synthesis is responsible for significant emissions of carbon dioxide worldwide. These emissions arise not only due to the energy requirements of chemical synthesis, but since hydrocarbon feedstocks can be overoxidized or used as hydrogen sources. Using renewable electricity to drive chemical synthesis may provide a route to overcoming these challenges, enabling synthetic routes which operate at benign conditions and utilize sustainable inputs. We are developing an electrosynthetic toolkit in which distributed feedstocks, including carbon dioxide, dinitrogen, water, and renewable electricity, can be converted into diverse fuels, chemicals, and materials.

In this presentation, we will first share recent advances made in our laboratory on nitrogen fixation to synthesize ammonia at ambient conditions. Specifically, our lab has developed a continuous lithium-mediated approach to ammonia synthesis and understood the reaction network that controls selectivity. Then, we will discuss how water can be used as a sustainable oxygen-atom source for epoxidation of olefins, providing a route to utilize oxidative equivalents in a water electrolyzer. These example reactions will illustrate how the modularity of chemical manufacturing could be enhanced through electrochemical routes which open up local and on-demand production of critical chemicals and materials.

Bio

Karthish Manthiram is the Theodore T. Miller Career Development Chair and Assistant Professor in Chemical Engineering at MIT. The Manthiram Lab at MIT is focused on the molecular engineering of electrocatalysts for the synthesis of organic molecules, including pharmaceuticals, fuels, and commodity chemicals, using renewable feedstocks. Karthish received his bachelor's degree in Chemical Engineering from Stanford University and his Ph.D. in Chemical Engineering from UC Berkeley, where his dissertation research was focused on the development of nanoscale materials for storing solar energy in chemical bonds. Most recently, he was a postdoctoral researcher at the California Institute of Technology, where he worked on developing new ionically-conductive polymers using olefin metathesis. Karthish's research has been recognized with several awards, including the NSF CAREER Award, DOE Early Career Award, American Institute of Chemical Engineers 35 Under 35, 3M Nontenured Faculty Award, American Chemical Society PRF New Investigator Award, Dan Cubicciotti Award of the Electrochemical Society, and Forbes 30 Under 30 in Science. Karthish's teaching has been recognized with the C. Michael Mohr Outstanding Undergraduate Teaching Award, the MIT ChemE Outstanding Graduate Teaching Award, and the MIT Teaching with Digital Technology Award. He serves on the Early Career Advisory Board for *ACS Catalysis* and on the Advisory Board for both *Trends in Chemistry* and the *MIT Science Policy Review.*