Using Electrochemistry to Understand and Control Thermochemical Catalysis

Yogesh Surendranath

Massachusetts Institute of Technology MIT

Frontier challenges in sustainability require precision control of catalysis occurring at solid-liquid interfaces. Unlike for gas-solid interfaces, at all solid–liquid interfaces, the exchange of ions and/or electrons with the solution can lead to electrostatic charging or polarization of the interface. However, the role of these charge transfer reactions and interfacial polarization is poorly understood in the context of thermochemical catalysis. We have developed general methods for tracking and controlling the degree of interfacial polarization during catalytic turnover and have used this approach to understand and tune thermochemical oxidation, hydrogenation, and acid catalysis. We have found that many net thermochemical reactions proceed as coupled electrochemical half-reactions and that interfacial polarization can be used to promote catalytic rates by orders of magnitude. These findings expose new opportunities to design and tune thermochemical catalysis by applying the principles of electrochemistry.