Energy, Environmental & Chemical Engineering

EECE Department Seminar

Friday, April 26, 2019
11:00am
Brauer Hall, room 12

Understanding Catalytic Reactions with Transient Kinetic Experiments

ABSTRACT

Catalytic reactions make modern life possible. Nearly half the nitrogen in our bodies has been through an industrial Haber-Bosch reactor and touched the surface of an iron catalyst to make ammonia for fertilizer. While we simply could not feed the 7.5 billion people on the planet without this chemical process it represents nearly 2% of our global energy consumption. In heterogeneous catalysis the nanoscale structures at the surface of a metal or metal oxide control the rates of different reaction steps. For making chemical processes more energy efficient we need a fundamental understanding of how these surface nanostructures of the catalyst can be manipulated to accelerate the reaction mechanism in the desired direction.

Transient kinetics provides a unique approach to understand how the surface of industrial materials control chemical reaction networks. The TAP (Temporal Analysis of Products) reactor system is a pulse response experiment that examines probe molecule interactions with the complex surface of industrial materials directly from an application setting. Though these experiments are conducted at conditions far removed from the industrial process, simple probe molecule reactions help us discriminate how similar catalyst compositions are different at a fundamental level. For example, addition of small amounts of cobalt to the surface of iron creates a material with better kinetic properties for ammonia decomposition than either iron or cobalt alone. We can learn a lot about the ammonia synthesis process by observing the reaction in reverse. At a global level the bimetallic material performs better, transient kinetic experiments using ammonia as a probe molecule will be presented that tell us *why*.

Rebecca R. Fushimi, Senior Staff Scientist,
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Dr. Fushimi is a research scientist at Idaho National Laboratory working in the area of catalysis and materials characterization. Her research is focused on using transient kinetics and the study of dynamics in chemical systems to understand gas/solid interactions at a fundamental level. She is an expert in the TAP (Temporal Analysis of Products) technique, of which there are less than 20 systems globally. Using TAP and other dynamic techniques her research group investigates selective oxidation, dehydrogenation, reforming reactions and ammonia synthesis on supported metals and mixed metal oxide catalysts. A main theme of this effort is to use a top-down approach to complexity of chemical systems by characterizing ultra-sparse perturbations in composition with intrinsic kinetic descriptors. This provides fundamental information of how new materials can be used more efficiently control the individual steps of a chemical reaction.

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