The CATALYSIS SOCIETY of Metropolitan New York
www.nycsweb.org

Wednesday, November 19, 2025 @ Columbia

Columbia Faculty house, Ivy Lounge Room, 1st floor
64 Morningside Dr
New York, NY 10027

Prof. Yuriy Roman
Chemical Engineering and Chemistry, MIT

Reimagining Thermochemical Catalysis: Promoting Reactions with Electric Fields

Catalysis has long relied on conventional handles such as temperature, pressure, and concentration to accelerate chemical reactions. Across biology and electrochemistry, electric fields provide an additional parameter to control rates. Enzymes exploit strong, oriented fields within their active sites to stabilize intermediates and accelerate turnover, while in electrochemistry, interfacial polarization dictates electron and proton transfer rates. In heterogeneous thermochemical catalysis, little is known about these effects, yet they may offer new opportunities to control reactivity.

In this talk, I will describe our group's efforts to harness electric fields to promote thermochemical reactions. For many electrochemical half-reactions, varying the applied potential accelerates rates by driving rate-controlling proton-coupled electron transfer (PCET) steps. We hypothesized that if an elementary PCET step were embedded within a thermochemical reaction, its strong potential dependence could be leveraged to enhance the overall rate. Because interfacial PCET involves proton exchange across the electric double layer, we anticipated that Brønsted acid catalysis, governed by proton transfer, would be particularly susceptible to polarization.

First, I will show how spontaneous interfacial fields at conductive particles dispersed in liquid media can measurably modulate turnover rates. Next, I will discuss how applied potentials lead to dramatic rate promotion in acid-catalyzed alcohol dehydration, accelerating rates by up to five orders of magnitude. Spectroscopic and kinetic analyses reveal that this acceleration arises from a field-driven increase in the population of reactive intermediates prior to the rate-determining step, providing a mechanistic basis for log-linear rate scaling with potential. Finally, I will highlight our development of polarized slurry reactors, which extend these principles from 2D electrodes to 3D catalyst slurries, enabling rate enhancements under conditions more suitable for scale-up. Our studies establish electric fields as a powerful, mechanistically grounded, and scalable lever to control thermochemical reactions, opening new opportunities for process intensification and catalyst design.

Speaker Bio

Prof. Yuriy Román was born in Mexico City, Mexico. He earned his B.S. in Chemical Engineering from the University of Pennsylvania in 2002 and his Ph.D. in Chemical Engineering from the University of Wisconsin-Madison in 2008 under the guidance of Prof. James Dumesic. He completed a postdoctoral fellowship at Caltech with Prof. Mark E. Davis before joining MIT Chemical Engineering in 2010, where he was promoted to Associate Professor in 2014 and Full Professor in 2020.

His research group designs heterogeneous catalysts and functional materials to tackle sustainability challenges in energy and chemicals. By tailoring the active site and its surrounding environment, and integrating synthesis, kinetics, mechanistic studies, and reactor engineering, his team develops catalytic processes that convert biomass into sustainable aviation fuels, upcycle plastic waste, and use electric fields to enhance catalytic efficiency. Together, these efforts build the foundation for a circular, low-carbon chemical industry. Prof. Román's contributions have been recognized with the NSF CAREER Award, the ACS Early Career in Catalysis Award, the AIChE Catalysis and Reaction Engineering Division Young Investigator Award, the Paul H. Emmett Award in Fundamental Catalysis, and the International Catalysis Award from the International Association of Catalysis Societies. He has also served the community as Programming Chair of the AIChE Catalysis and Reaction Engineering Division, Chair of the Lignin Gordon Research Conference, and as an Editorial Board Member for ACS Catalysis and Catalysis Reviews.

Schedule	
Social Hour	6:00 PM
Dinner	6:30 PM
Presentation, Q&A	7:30 PM

Meeting Fees	
Non-members	$50
Students	$25 (Student Members = $10)
Retired/Post-Doc/Unemp.	$40 (Members = $30)
Annual Membership Dues	***$35 (Students = $15)***

There will be no student speaker this meeting

Deadline for reservations is **5:00PM Thursday, November 13, 2025**
Please RSVP online using the online form.
To renew your membership, please visit this link.