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The Catalysis Club of Philadelphia

Thursday, November 10th, 2022

Brandywine Plaza Hotel

630 Naamans Road, Claymont, DE 19703

CCP Award Lecture

**Preparation and applications of bimetallic catalysts using
electroless deposition methods**

Speaker: Prof. John Monnier

University of South Carolina

**Metathesis, Molecular Redistribution of Alkanes, and the
Chemical Upcycling of Low-Density Polyethylene**

Student Speaker: Doyoung Kim

University of Delaware

Meeting Schedule:

Social Hour 5:30 PM

Dinner 6:30 PM

Meeting 7:30 PM

Meeting Fees:

Members: \$45.00

Non-Members: \$55.00

Stud. & Retired Members: \$35.00

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Meeting and Meal reservations –

Please register online by **Thursday,
November 3rd** at

[http://catalysisclubphilly.org/meeting-
registration-with-paypal/](http://catalysisclubphilly.org/meeting-registration-with-paypal/)

Or contact our Treasurer Steve

Hardwick (sjh.wilm.de@gmail.com) or

Chair Udayshankar Singh

(udayshankar.singh@grace.com)

Membership – Dues for the 2022-23 season will be \$25 (\$5 for the local chapter and \$20 for the national club). Dues for students, post-docs and retirees will be \$10 (\$5 for the local club and \$5 for the national club).

The Catalysis Club of Philadelphia

November 10th, 2022

Brandywine Plaza Hotel

630 Naamans Road, Claymont, DE 19703



Prof. John R. Monnier
2022 CCP Award winner

Preparation and applications of bimetallic catalysts using electroless deposition methods

Department of Chemical Engineering, University of South Carolina, Columbia SC, 29208

Abstract:

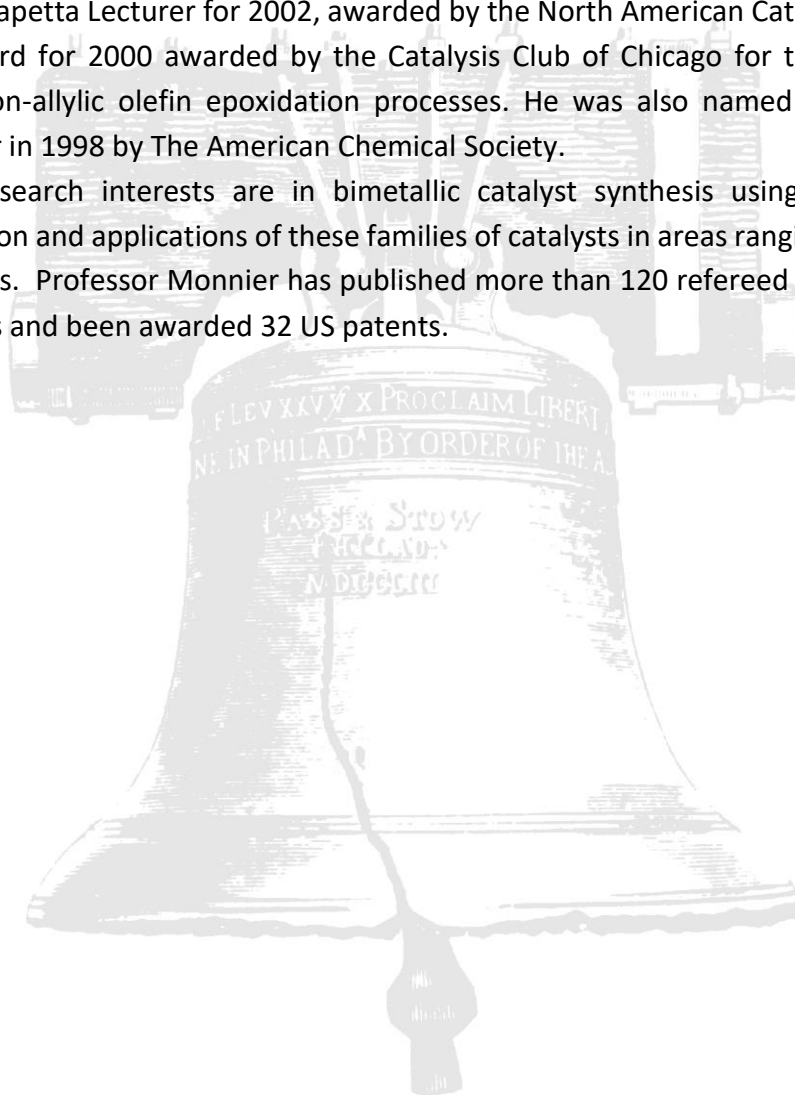
The workhorse of chemical catalysis has been supported metal catalysts and much has been done to modify and tune these catalysts for particular reactions. However, many catalytic reactions in today's chemical environment involve unconventional feeds such as biomass and natural gas components, different fuel cell chemistries, and more stringent environmental regulations that require catalysts with different properties.

One way of making better catalysts is to add a secondary metal to form bimetallic catalysts, which can modify performance by ensemble, electronic, and/or bifunctional effects. In all cases, it is intuitive and critical that both metal atoms are in contiguous contact for the bimetallic effect(s) to occur most efficiently and that the coverage of the second metal can be controlled. Standard methods, however, often provide inadequate control over placement of each metal to yield catalysts containing both isolated monometallic particles and bimetallic particles with varying compositions and distributions. We have developed the process of electroless deposition (ED) to deposit a reducible metal salt using a water-soluble reducing agent onto the surface of a pre-existing monometallic catalyst. In this manner, coverages of the reduced metal can be systematically varied from fractional monolayers to multilayers to satisfy a large number of catalytic needs, ranging from selective hydrogenation to selective oxidation to fuel cell applications. In this presentation, I will describe some of the fundamentals of electroless deposition and present applications of these catalysts for reactions of interest to the catalyst community.

Speaker Bio:

John Monnier is Professor of Chemical Engineering at the University of South Carolina, after retiring in 2004 after 32 years of service as Technology Fellow at Eastman Chemical/Eastman Kodak Research Labs. Monnier has spent his entire career in heterogeneous catalysis and conducted research in virtually all areas of catalysis, noteworthy for the discovery and commercialization of the epoxidation of butadiene, which led to his election to the National Academy of Engineering in 2017. Other significant awards include the Catalysis and Reaction Engineering Practice Award, 2017, from AIChE. F. G. Ciapetta Lecturer for 2002, awarded by the North American Catalysis Society, the Herman Pines Award for 2000 awarded by the Catalysis Club of Chicago for the discovery and development of non-allylic olefin epoxidation processes. He was also named the Outstanding Industrial Innovator in 1998 by The American Chemical Society.

Current research interests are in bimetallic catalyst synthesis using the method of electroless deposition and applications of these families of catalysts in areas ranging from chemical catalysis to fuel cells. Professor Monnier has published more than 120 refereed journal articles in the field of catalysis and been awarded 32 US patents.



Metathesis, Molecular Redistribution of Alkanes, and the Chemical Upcycling of Low-Density Polyethylene



Doyoung Kim

*Advisor: Prof. Raul F. Lobo
University of Delaware*

Catalytic alkane metathesis—comprising tandem (de)hydrogenation and olefin metathesis—is a promising technology for polyethylene (PE) upgrading due to its molecular redistribution capability¹⁻². However, the use of rhenium oxide catalyst for olefin metathesis reaction in upgrading of PE has limited the economical feasibility because rhenium oxide is costly and cannot be applied at high temperatures where reaction kinetics are most favorable (due to its high volatility). Herein, a new strategy for PE upgrade via alkane metathesis is presented, in which the olefin metathesis reaction step is catalyzed by a relatively less expensive WO_x/SiO_2 catalyst (cost ratio; rhenium/tungsten = 24).

Zeolite 4A adsorbent acts as an essential component to protect the metathesis active sites from poisoning by in-situ-generated oxygenates in a batch reaction system³. High conversion of 1-hexadecene (96%) and n-hexadecane (92%)—surrogates of long-chain molecules—demonstrate the high reactivity of WO_x/SiO_2 metathesis catalyst for olefin and alkane metathesis reactions, respectively, at moderate reaction temperatures of 300 °C for 2 h. Pretreatment temperature and length of the short *n*-alkane-chain solvent have significant effects on the reactivity and selectivity of model alkane metathesis reactions. Results for applying the developed reaction system to low-density PE (LDPE) with *n*-decane as the short *n*-alkane demonstrate a remarkable potential for PE upgrading with advantages of short reaction times (3 h), the low solvent to LDPE mass ratio (6 w/w), and production of solid products with narrow molecular weight distributions ($\mathcal{D} = 1.2$).

[1] X. Jia, C. Qin, T. Friedberger, Z. Guan, Z. Huang, *Sci. Adv.* 2, 1–8 (2016).

[2] L.D. Ellis, S. v. Orski, G.A. Kenlaw, A.G. Norman, K.L. Beers, Y. Román-Leshkov, G.T. Beckham, *ACS Sustain. Chem. Eng.* 9, 623–628 (2021).

[3] S. Lwin, Y. Li, A.I. Frenkel, I.E. Wachs, *ACS Catal.* 6, 3061–3071 (2016).

Speaker Bio

Doyoung is a 6th year PhD student in the Lobo group at the University of Delaware. Doyoung received his bachelor's degree in Chemical Engineering at the Hanyang University in South Korea. His research interests have been synthesis, characterization of novel catalysts such as zeolite-encapsulated metal nanoparticle catalysts, and its application to tandem reaction in biomass upgrade. His current research focuses on developing effective catalytic deconstruction and upgrading strategies for plastics waste.