

Officers

CHAIR

Udayshankar Singh
W. R. Grace & Co.

CHAIR-ELECT

Angela Zheng
Johnson Matthey

PAST CHAIR

Thomas Yeh
Air Products

TREASURER

Steve Hardwick
W.L. Gore (Retired)

SECRETARY

Mengjie Fan
University of Pennsylvania

PROGRAM CHAIR

Weijian Diao
Villanova University

ARRANGEMENTS CHAIR

Tian Ren
University of Pennsylvania

DIRECTOR, SPONSORSHIP

Donna Liu
Johnson Matthey

DIRECTOR, STUDENT POSTER

Donghua Zuo
Elesent Clean Technologies

DIRECTOR, MEMBERSHIP

Leo DeRita
Johnson Matthey

WEBMASTER

Dang Nguyen
Lehigh University

NATIONAL REPRESENTATIVE

Michael Smith
Villanova University

The Catalysis Club of Philadelphia

Thursday, September 22nd, 2022

Brandywine Plaza Hotel

630 Naamans Road, Claymont, DE 19703

F.G. Ciapetta Award Lecture

Speaker: Dr. Sourav K. Sengupta

Catalysis – An Indispensable Tool for Sustainable Development

DuPont

Student Speaker: Bradie Crandall

Techno-economics and Scale-up of Electrochemical CO₂

Reduction to Carboxylic Acids

University of Delaware

Meeting Schedule:

Social Hour 5:30 PM

Dinner 6:15 PM

Meeting 7:15 PM

Meeting Fees:

Members: \$45.00

Non-Members: \$55.00

Stud. & Retired Members: \$35.00

Thanks to our sponsors:

Platinum:

W. R. Grace & Co

Gold:

Johnson Matthey

Zeolyst International

Ecovyst Inc.

ExxonMobil

Silver:

Meeting and Meal reservations –

Please register online by **Thursday,**

September 15th at

<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

September 22nd, 2022

Brandywine Plaza Hotel

630 Naamans Road, Claymont, DE 19703



Dr. Sourav K. Sengupta

F.G. Ciapetta Lectureship Awardee

Catalysis – An Indispensable Tool for Sustainable Development

Water & Protection, DuPont, Wilmington, DE 19803

Abstract: In the past three decades, the chemical industry has been in the forefront of making many novel and ingenious innovations to design cost-advantaged, inherently safe, environmentally friendly, and sustainable processes for the production of fuels, chemicals, and advanced materials. However, there is still a persistent public perception that the chemical industry is not doing enough to develop safe and sustainable chemistry. As a matter of fact, a large number of scientists, environmental scholars, business leaders, and governmental policymakers believe that the chemical industry must do more to develop sustainable processes to save our planet from the dire consequences of climate change. During the last three decades, DuPont has been in the forefront of developing many sustainable products and processes.

Catalysis is an indispensable tool for sustainable development of chemicals, fuels, and advanced materials manufacturing processes. It plays a crucial role in improving process efficiencies and process intensification. These lead to increased atom utilization, reduced by-product formation, cheaper processes, and lower capital investment – the basic tenets of sustainable process and product development. Also, there is an increasing interest in using renewably sourced feedstocks for the production of fuels, chemicals, and advanced materials due to fluctuations in raw material prices, a limited availability of petroleum resources, and increasing consumer consciousness about sustainable processes.

Although catalysis is a major tour-de-force in driving this efficacious and green chemistry revolution, the role of reaction engineering, reactor design, process development, and operating conditions cannot be underestimated. I will discuss some of the fundamental concepts of catalysis and how they are linked to sustainable development of chemical processes of industrial relevance. Along with that, I'll try to bring forward the role of science and engineering in catalysis, with particular emphasis on catalyst attributes and catalyst development in industrial processes. The presentation will include case studies in hydrogenation, hydrodeoxygenation, and solid acid catalyzed reactions.

catalysisclubphilly.org

Speaker Bio:

Dr. Sourav Sengupta, a DuPont Laureate, has been with DuPont for over 30 years. He received his PhD degree in Chemical Engineering from the University of Delaware in 1991. Throughout his career, he has made significant business impact across DuPont and technical contributions in the field of catalytic science and technology. He has invented, innovated, and implemented a plethora of new processes and products including, a cheaper and inherently safer process for the synthesis of an aramid monomer; a modular, on-site HCN manufacturing process by reacting methane and ammonia in the presence of a Pt-Rh gauze catalyst using induction heating; a novel fixed bed hydrogenation reactor technology to manufacture a key intermediate used in the synthesis Sevoflurane; an inhalation anesthetic; and a higher activity sulfuric acid catalyst.

A collaborative leader and a great team player, Sourav knows how to get results by solving plant and process-related problems, combining an in-depth knowledge of the fundamentals of science with a keen and meticulous sense of detail. More recently, Sourav and his team have worked on sustainable chemical manufacturing processes and invented many biomass hydrodeoxygenation catalysts for converting cellulose-derived molecules to alpha-omega diols by optimizing bicomponent cooperativity in surface reactions and harnessing the influence of water to reduce activation barriers. Furthermore, they also resolved a challenging catalyst deactivation problem for furan hydrogenation reaction and improved catalyst productivity in the Bio-THF process.

Sourav is well recognized internally and externally as an innovator, a problem-solver, and a world-class expert in the field of catalysis and reaction engineering. His seminal work in heterogeneous catalysis, particularly in hydrogenation, hydrodeoxygenation, and hydrogen cyanide synthesis, has had far-reaching influence, as is evident from the sheer volume of his publications and the invited lectures he has given in his long and illustrious career in DuPont. He has over 80 issued and provisional US patents, publications in peer-reviewed journals, a book chapter, and invited lectures and presentations at national and international conferences. In addition to his work at DuPont, he has been recognized as a world class expert in the catalysis community, as exemplified by his receiving the Philadelphia Catalysis Club Award (2015) and F. G. Ciapetta Lectureship in Catalysis by the North American Catalysis Society (2022).

In 2020, Dr. Sengupta was honored with the appointment of DuPont Laureate, which is the highest level for technological achievement in DuPont.

Techno-economics and Scale-up of Electrochemical CO₂ Reduction to Carboxylic Acids

Bradie S. Crandall

Advisor: Prof. Feng Jiao, University of Delaware

The cost of renewable electricity has declined rapidly in recent years; solar photovoltaics and onshore wind are now the cheapest means to produce electricity in the United States. Carboxylic acid production (formic acid and acetic acid) via CO₂ electrolysis allows these inexpensive green electrons to be leveraged to help decarbonize society. Formic acid, the simplest of the CO₂ derived carboxylic acids, can be used as a hydrogen carrier to reduce the costs associated with the storage and transmission of green hydrogen. As both a chemical feedstock and an energy carrier, a robust hydrogen supply chain is critical for realizing the green hydrogen economy and achieve multi-sector decarbonization. The storage and transmission costs associated with the delivery of hydrogen currently pose significant barriers to economic feasibility due to the need for expensive cooling or pressurization. These supply chain limitations may be overcome with the aid of liquid green hydrogen carriers, such as ammonia, methanol, and toluene/methylcyclohexane (two-way carrier) which have been frequently studied, as well as formic acid, which has received less attention. A detailed supply chain analysis was performed to elucidate which liquid green hydrogen carrier is best under a variety of conditions. This work informs the selection of a suitable green hydrogen carrier, which is essential to decarbonize at the rate needed to avoid climate catastrophe.

Another carboxylic acid that can be produced via CO₂ electrolysis is acetic acid, one of the highest volume chemicals produced in the United States and a promising substrate for sunlight-free food production as demonstrated in the Jiao Group's recent work. Direct CO₂ electrolysis to multi-carbon products like acetic acid is limited in stability and selectivity. CO₂-CO-acetate tandem systems offer a promising solution to improve performance. However, the downstream costs associated with this process for sustainable acetic acid production have been prohibitively expensive due to low concentration and purity at the electrolyzer outlet. A state-of-the-art system capable of producing concentrated acetate (>7.5 M) at high purity (>99%) is offered to overcome this challenge. Techno-economic analysis demonstrates the ability for this technology to pave the way for commercialization at scale by significantly reducing downstream energy usage. Finally, ongoing efforts to bring this technology from the watt to the kilowatt-scale will be presented.

Speaker Bio

Bradie S. Crandall is a 3rd year PhD candidate in the Department of Chemical and Biomolecular Engineering at the University of Delaware. He is advised by Professor Feng Jiao, Director of the Center for Catalytic Science and Technology. Bradie's research interests lie in the study of CO₂ electrolysis, specifically the scale-up and techno-economic aspects. He is a DENIN Environmental Fellow, Axalta Bright Futures Scholar, and University of Delaware Climate Fellow. He completed his Bachelor's degree in Chemical Engineering at the University of South Carolina where he was a Magellan Scholar and was awarded the Outstanding Senior Award for the class of 2020. In addition to his PhD studies, Bradie is on the Student Advisory Council for the Biden Institute and serves as Graduate Student Government Senator and Sustainability Committee Chair for his department. Upon the completion of his PhD, Bradie is pursuing a career in science policy advisement on Capitol Hill in Washington, DC.