CATALYSIS CLUB OF PHILADELPHIA

Promoting Catalytic Science and Technologies

The Catalysis Club of Philadelphia

(In Person) Thursday, March 20th, 2025

Doubletree by Hilton Hotel Wilmington – Wilmington, Delaware

4727 Concord Pike, Wilmington, DE 19803

Flash talk: Improved Structuring Technology for Sorbents and Catalysts

Speaker: Dr. Bob Grasso *(W.L. Gore & Associates)*

Student talk: Two-Dimensional MXene Supported Metal Catalysts for Plastic Waste Hydrogenolysis

Student Speaker: Ali Kamali *(University of Delaware)*

Keynote: Introduction to Additive Manufacturing and Energy Applications

Speaker: Prof. Kelvin Fu *(University of Delaware)*

Meeting Agenda:

Social Hour ..... 5:30 PM
Dinner ..... 6:30 PM
Meeting ..... 7:30 PM

Meeting Registration:

Members: $45.00
Non-Members: $55.00
Stud. & Retired Members: $35.00

Please register online for this In-person meeting by ***Thursday, March 13th*** at CCP website.

Meal Selection (Included):

Please make one selection for your dinner (included in registration) when you sign-up for the meeting from the following options:

1. Boneless beef short rib with peppercorn demi glace. Dessert: Brownie with anglaise sauce.
2. Apple cider glazed chicken with toasted pecans. Dessert: Brownie with anglaise sauce.
3. Winter vegetable stew (vegan). Dessert: Brownie with anglaise sauce.

Starter: Butternut squash bisque, toasted pumpkin seeds, dried cranberry
Side: Fingerling potatoes with broccoli

Membership Registration:

Membership dues for CCP 2024-25 meeting 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). Please sign-up membership (Link) for more benefits on meeting registrations and net-working events!

Please contact our Treasurer Steve Hardwick (sjh.wilm.de@gmail.com) or Chair Zhuonan (Nick) Song (zsong@wlgore.com) or Program Chair Brandon Bukowski (bbukows1@jhu.edu) if you need any assistance

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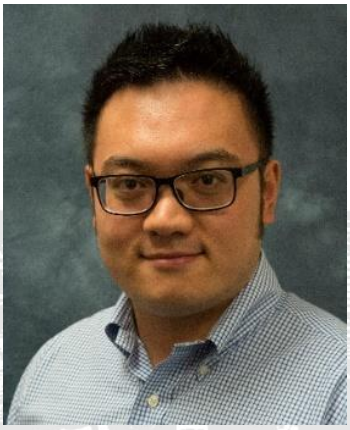

Prof. Kelvin Fu

Introduction to Additive Manufacturing and Energy Applications

University of Delaware

Additive manufacturing, commonly referred to as 3D printing, revolutionizes the way products are conceived, designed, and fabricated, offering unprecedented opportunities to address pressing challenges in battery and chemical manufacturing. This seminar begins with a comprehensive review of the fundamental principles, techniques, and recent developments in additive manufacturing. It then presents my research efforts to apply these technologies in the design and optimization of energy storage systems, process intensification, and sustainable chemical production. By highlighting case studies and emerging trends, this presentation aims to significantly underscore the transformative potential of 3D printing in greatly fostering innovation, reducing waste, and enhancing performance.

Speaker Bio:

Kelvin Fu is the Terri Connor Kelly and John Kelly Career Development Assistant Professor in Mechanical Engineering at the University of Delaware and a faculty member at the Center for Composite Materials (CCM). He is the co-founder of CarbonForm Inc. and serves as an assistant editor for Composites Part B: Engineering. Fu directs the Composites & Additive Manufacturing (CAM) Laboratory, where his research advances composite materials and additive manufacturing technologies to address both fundamental and applied challenges in the energy sector. Fu is recognized as a Clarivate Highly Cited Researcher (2024-2022) and was honored with the 2023 Outstanding Early Career Faculty Award at the University of Delaware. His innovation in 3D printing was a finalist for the TCT Hardware Award at the TCT Awards 2024 and a winner/finalist of several Awards for Composite Excellence (ACE). Fu leads four DOE-funded projects with a combined funding total exceeding $8 million.

Improved Structuring Technology for Sorbents and Catalysts

Dr. Bob Grasso

W.L. Gore & Associates

Structuring a sorbent or catalyst can provide a number of improvements in performance over the conventional bead/pellet forms. These improvements include better mass transfer kinetics, lower pressure drop, and resistance to fluidization at higher flow rates. However, there are usually tradeoffs to structuring a sorbent using the usual methods of extrusion or coating technologies.

Gore has demonstrated the ability to structure a variety of sorbents and catalysts at high loadings (85-90 wt.%) into a unique composite tape form known as GIST ("Gore Integrated Spacer Technology"). This short presentation will describe the advantages of GIST composites and their devices compared to a conventional packed bed of beads/pellets or other structured forms.

Speaker Bio:

Bob Grasso is currently a technologist at W.L. Gore & Associates in Elkton MD. As an undergrad, Bob received his B.A. in Chemistry from Washington & Jefferson College where he was elected to Phi Beta Kappa and Phi Lambda Upsilon. After receiving his M.S. and Ph.D. in Macromolecular Science and Engineering from Case Western Reserve University as a National Science Foundation Graduate Fellow, he joined the Aerospace Division of Hercules Incorporated, working with liquid crystalline materials for ferroelectric displays and non-linear optical devices, as well as enabling several large DOD contracts. He then went on to form the computational chemistry group there and had a significant impact on many R&D projects, as well as commercial products, using both theory and experiment. In 2010, Bob joined Gore, where he applied his experience in characterization and processing to making improved active-composite materials. He has a passion towards the fabrication and understanding of a wide range of materials to address industrial needs in the general areas of chemical capture and conversion.

Two-Dimensional (2D) MXene Supported Metal Catalysts for Plastic Waste Hydrogenolysis

Ali Kamali

Advisor: Prof. Dongxia Liu, University of Delaware

Abstract: The exponential increase in global plastic production has significantly outpaced our current waste management capabilities, leading to severe environmental, energy, and economic impacts. The reliance on landfilling and incineration as major methods of managing plastic waste does decrease the volume of discarded materials but creates substantial negative impacts in terms of energy utilization and greenhouse gas emissions. The alternative method of recycling is a promising solution, however the rate of utilization in the United States is dismally low at only 5-6%. Furthermore, the strong C-C backbone of polyolefins makes them particularly challenging to depolymerize and recycle with existing chemical recycling methods such as pyrolysis and gasification which have low product selectivity and high energy consumption. This situation underscores the critical need to develop sustainable recycling methods to address the rapid growth of plastic production and subsequent waste.

Recent advancements in the hydrogenolysis of plastic waste using ruthenium (i.e., Ru) have shown significant potential for upcycling polyolefins into valuable fuels. Due to their high activity, Ru nanoparticles have been extensively utilized in the plastic hydrogenolysis process, demonstrating the ability to rapidly break C-C bonds in polyolefins such as polyethylene. Despite these promising aspects, one major flaw of this process is the tendency of Ru-based catalysts to break terminal C-C bonds, leading to the formation of low-value methane gas which diminishes the overall yield of valuable hydrocarbon products. Additionally, the high density of polyolefin macromolecules creates significant external mass transport diffusion limitations which can adversely affect the efficiency of depolymerization reaction.

MXenes are a class of two-dimensional materials derived from MAX phases that exhibit exceptional chemical, physical, and mechanical properties, making them promising candidates for catalytic applications including plastic depolymerization. MXenes' high surface area in combination with the presence of functional groups on their nanosheets enable the dispersion of metal active sites as well as modification of their electronic charges, thereby enhancing catalytic activity. This structure allows for higher accessible active sites and the incorporation of ionic

crosslinkers (like Ru) during synthesis can prevent MXene nanosheets from re-stacking or aggregating, further enhancing their catalytic capability. In this talk, we discuss an innovative approach to enhance the hydrogenolysis of plastic waste by leveraging the unique properties of MXene materials supported with Ru nanoclusters. To address the mass transfer diffusion problem of plastics, we modified the interlayer spacing of MXene nanosheets to enhance the efficient contact between polymer substrates and catalytic sites. The use of this material in polyolefins hydrogenolysis demonstrated a remarkable conversion rate and selectivity under mild conditions. These findings highlight the potential of MXene materials in addressing the challenges associated with the catalytic depolymerization of plastics.

Speaker Bio: Ali Kamali is a fifth-year PhD candidate at the University of Delaware, working under the guidance of Prof. Dongxia Liu. His research primarily focuses on the development of two-dimensional catalysts for the deconstruction of plastic waste into high-value products such as fuels, and olefins. Additionally, his work explores the effects of defective metal oxides on Aniline hydrogenation and plastic upcycling. Ali earned his Master's degree in chemical engineering from the University of Tehran, in Iran before joining UD.