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Speaker: Prof. A.-H. Alissa Park

*Columbia University, Dept. of Earth and Environmental Engineering
& Department of Chemical Engineering*

***Towards Sustainable Energy and Materials:
Carbon Capture, Utilization and Storage (CCUS)***

Graduate Student Speaker: Heng Dai

Chemical and Biomolecular Engineering, University of Houston

Finned Zeolite Catalysts

Meeting Schedule:

6:30 PM: *Networking Time*

7:00 PM: *Student Speaker*

7:20 PM: *Main Speaker*

Meeting Fees:

Free to CCP Members

Meeting Etiquette:

Please remember to mute your microphone and arrive early to solve any technical issues.

Webinar Registration:

Please register online by **Wednesday, October 14th** using this [LINK](#) or notify Arrangements Chair [Jian Chang \(CJ\)](#).

A webinar meeting invite will be provided on October 15th to all those who register.

Membership:

Dues for the 2020-21 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 local club and \$5 for national club). Use this [LINK](#) for membership registration.

Catalysis Club of Philadelphia

Webinar: 6:30pm EST, Thursday, October 15th, 2020

Webinar link shared after registration

Towards Sustainable Energy and Materials: Carbon Capture, Utilization and Storage (CCUS)

A.-H. Alissa Park

Lenfest Chair in Applied Climate Science

Department of Earth and Environmental Engineering & Department of Chemical Engineering

Director of the Lenfest Center for Sustainable Energy,

Columbia University, New York, NY 10027.

Abstract:

The atmospheric concentration of CO₂ has naturally fluctuated on the timescales of ice ages. Concerns, however, stem from the recent dramatic increase in CO₂ concentration, which coincides with global industrial development. This rise is mainly due to the high use of fossil fuels during power generation and chemical production. In order to meet the ever-increasing global energy demands while stabilizing the atmospheric CO₂ level, the development of carbon capture, utilization and storage (CCUS) technologies is one of the critical needs. In particular, there has been significant efforts to develop CO₂ capture solvents and some (e.g., amine-based aqueous solvents) have shown very promising results. Unfortunately, the energy requirement for the current aqueous solvent systems is still considered to be too high. Thus, efforts have been focused on the development of second and third-generation CO₂ capture solvents which are often water-free. Nanoparticle Organic Hybrid Materials (NOHMs) are a new class of organic-inorganic hybrids that consist of a hard nanoparticle core functionalized with a molecular organic corona that possesses a high degree of chemical and physical tunability. NOHMs are liquid-like, non-volatile and stable over a very wide temperature range, which make them interesting materials for various energy and environmental applications. While their CO₂ capture efficiency and selectivity are great, like other anhydrous CO₂ capture solvents, NOHMs suffer from high viscosity. Thus, an innovative encapsulation system has been developed to create large gas-liquid interfaces for CO₂ capture using these viscous solvents and encapsulated solvents show greatly improved CO₂ capture rates. Furthermore, it has recently been discovered that NOHMs have interesting electrolyte properties which may allow the CO₂ capture to be pulled by the in-situ CO₂ conversion reactions. The development of these unique nanoscale hybrid materials will not only advance CO₂ capture materials design but also introduce unique research opportunities in various energy and environmental fields.

Speaker Biography: A.-H. Alissa Park is the Lenfest Chair in Applied Climate Science of Earth and Environmental Engineering & Chemical Engineering at Columbia University. She is also the Director of the Lenfest Center for Sustainable Energy. Her research focuses on sustainable energy and materials conversion pathways with emphasis on integrated Carbon Capture, Utilization and Storage (CCUS) technologies. Park group is also working on Direct Air Capture of CO₂ and Negative Emission Technologies including BioEnergy with Carbon Capture and Storage (BECCS). Park received a number of professional awards and honors including the Mid-



Career Faculty Award at Columbia University (2020), U.S. C3E Research Award (2018), PSRI Lectureship Award in Fluidization at American Institute of Chemical Engineers (2018), American Chemical Society Energy and Fuels Division - Emerging Researcher Award (2018), International Partnership Award for Young Scientists of Chinese Academy of Sciences (2018), Janette and Armen Avanesians Diversity Award at Columbia University (2017), American Chemical Society WCC Rising Star Award (2017), James Lee Young Investigator Award (2010) and the National Science Foundation CAREER Award (2009). Park also led a number of global and national discussions on CCUS including the Mission Innovation Workshop on Carbon Capture, Utilization and Storage (2017) and the National Petroleum Council CCUS Report (2019). She is a fellow of the American Chemical Society and the Royal Society of Chemistry.



Finned Zeolite Catalysts

Heng Dai¹, Yufeng Shen¹, Taimin Yang², Choongsze Lee³, Donglong Fu⁴, Ankur Agarwal¹, Thuy T. Le¹, Michael Tsapatsis^{3,5}, Jeremy C. Palmer¹, Bert M. Weckhuysen⁴, Paul J. Dauenhauer³, Xiaodong Zou², Jeffrey D. Rimer¹

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Abstract

Confined channels and cages of zeolites have been widely used as shape-selective heterogeneous catalysts in the (petro)chemical industry. A common objective in the design of zeolite is to overcome the inherent mass transport limitations of micropores. The advent of two-dimensional¹ or self-pillared zeolites² exhibit superior catalytic performance to conventional zeolites. In this poster, we will describe an alternative approach to reduce the internal diffusion limitations of zeolites via the introduction of fin-like protrusions on zeolite surfaces by secondary growth. We will discuss the synthesis of multiple frameworks with nano-sized fins (size α) which exhibit an identical crystallographic registry with the interior crystal (size β) and show their superior catalytic performance relative to conventional analogues.³

This new class of mass transport enhanced zeolites were synthesized by secondary growth using finely tuned composition that allows for the epitaxial growth of fins on the surface of seed crystals. Here we will discuss examples of several finned zeolites with disparate 3-dimensional pore networks to demonstrate the broader applicability of this approach. We also demonstrate a proof of concept using commercial zeolite samples where finned analogues improve their catalytic performance. Our studies of synthesis and methanol to hydrocarbon (MTH) catalytic testing as benchmark reaction are coupled with state-of-the-art characterization using techniques such as high-resolution electron tomography, operando spectroscopy, novel acid titration methods, and molecular modeling to correlate structural features of finned zeolites and their diffusion properties with enhanced catalyst performance.

References:

1. Choi, M., et al. *Nature* 461 (2009) 246-249.
2. Zhang, X., et al. *Science* 336 (2012) 1684-1687.
3. Dai, H., et al. *Nature Materials* 19 (2020) 1074–1080

Speaker Biography:

Heng Dai is a fifth year PhD student at University of Houston. Dai received B.S. degree in Chemical Engineering from Tianjin University, China and M.Eng in Chemical Engineering from Rice University. During the doctoral research under the supervision of Dr. Jeffrey Rimer, Dai focuses on the rational design of heterogeneous nanoporous catalysts in C1 chemistry. Dai received the Travel Award from

17th International Congress on Catalysis (ICC) and Best Poster Award from 2020 Great Plains Catalysis Society Symposium. He is a member of American Institute of Chemical Engineers (AIChE), Southwest Catalysis Society (SWCS) and Great Plain Catalysis Society (GPCS).

