

**Officers**

CHAIR  
Jacob Dickinson  
DuPont

CHAIR-ELECT  
Parag Shah  
PQ Corporation

PAST CHAIR  
Eric Sacia  
DuPont

TREASURER  
Joshua Pacheco  
Zeolyst International

SECRETARY  
Jennifer Lee  
University of Pennsylvania

PROGRAM CHAIR  
Srinivas Rangarajan  
Lehigh University

ARRANGEMENTS CHAIR  
Chao Lin  
University of Pennsylvania

DIRECTOR, SPONSORSHIP  
Bill Borghard  
Rutgers University

DIRECTOR, STUDENT POSTER  
Marat Orazov  
University of Delaware

DIRECTOR, MEMBERSHIP  
Lifeng Wang  
Zeolyst International

WEBMASTER  
Thomas Yeh  
Johnson Matthey

NATIONAL REPRESENTATIVE  
Dion Vlachos  
University of Delaware

**Catalysis Club of Philadelphia**

**Wednesday, November 6<sup>th</sup>, 2019**

Lehigh University, Iacocca Hall  
111 Research Dr, Bethlehem, PA 18015

**Speaker: Prof. Abhaya K. Datye**

**Burwell Lectureship**

***Catalysis Club of Philadelphia and Catalysis Society of  
Metropolitan New York Joint Meeting  
University of New Mexico***

**Atom Trapping: Key to the Design of Thermally  
Stable and Regenerable Single Atom Catalysts**

*And*

**Student Poster Competition**

***See the call for abstracts for directions to submit a poster***

*October 30<sup>th</sup>, 2019 deadline for submission*

**Meeting Schedule:**

*Poster Setup ..... 5:00 PM  
Poster Competition .. 5:20 PM  
Dinner ..... 6:50 PM  
Meeting ..... 7:40 PM  
Poster Awards ..... 8:35 PM*

**Meeting Fees:**

*Members: \$40.00  
Non-Members: \$45.00  
Stud. & Retired Members: \$25.00  
Students presenting posters: Free*

**Menu**

***Western Asian Buffet***

- *Vegetable Maki*
- *Vegetable Salad*
- *Shrimp and String Beans*
- *Spicy Chicken*
- *Dumplings*
- *Miso Baked Cod*
- *Yakitori Beef Madallions*
- *Rolls, Fruit, and Desert*

**Meal selections not required  
for this meeting – Please**

register online by  
**Wednesday, October 30<sup>th</sup>** at  
<http://catalysisclubphilly.org/>  
or notify your company  
representative or our  
Treasurer Josh Pacheco  
([Josh.Pacheco@pqcorp.com](mailto:Josh.Pacheco@pqcorp.com))  
or Chair Jacob Dickinson  
([Jacob.G.Dickinson@dupont.com](mailto:Jacob.G.Dickinson@dupont.com))

**Membership** - Dues for the  
2019-20 season will be \$25.00  
(\$5.00 for the local chapter  
and \$20.00 for the national  
club). Dues for students, post-  
docs and retirees will be  
\$10.00 (\$5.00 for local club  
and \$5.00 for national club).

# Catalysis Club of Philadelphia

Wednesday, November 6<sup>th</sup>, 2019

Lehigh University, Iacocca Hall

111 Research Dr, Bethlehem, PA 18015



**Prof. Abhaya K. Datye**

## **Atom Trapping: Key to the Design of Thermally Stable and Regenerable Single Atom Catalysts**

*Department of Chemical and Biological Engineering and Center for Micro-Engineered Materials,  
University of New Mexico, Albuquerque, NM 87131, USA.*

**Abstract:** Heterogeneous catalysts represent the mainstay of the chemical industry, and a large majority involve nanoparticles on a support. Decreasing size of the nanoparticles leads to better utilization of the precious metals, with the highest atom efficiency being achieved when the metal is atomically dispersed in the form of isolated atoms. Isolated atoms become mobile at elevated temperatures, causing agglomeration into nanoparticles. Our research is focused on developing methods to control the growth of particle size and the transformation of nanoparticles into isolated single atoms [1-3].

Supports differ in their ability to maintain small particles. The figure below shows STEM images of three catalysts that contain 1 wt% Pt synthesized using the same amine precursor. The catalysts were all calcined at 500 °C in air to decompose the precursor. It is evident that very different sized Pt particles are formed. The ceria support contains isolated Pt atoms, the alumina support shows sub-nanometer sized particles while the MgAl<sub>2</sub>O<sub>4</sub> support shows larger particles. The conventional term used to describe these differences is metal-support interactions (MSI), which is meant to suggest bonding of the metal nanoparticle with the oxide support. But the term MSI fails to capture the underlying mechanism that leads to these observations.

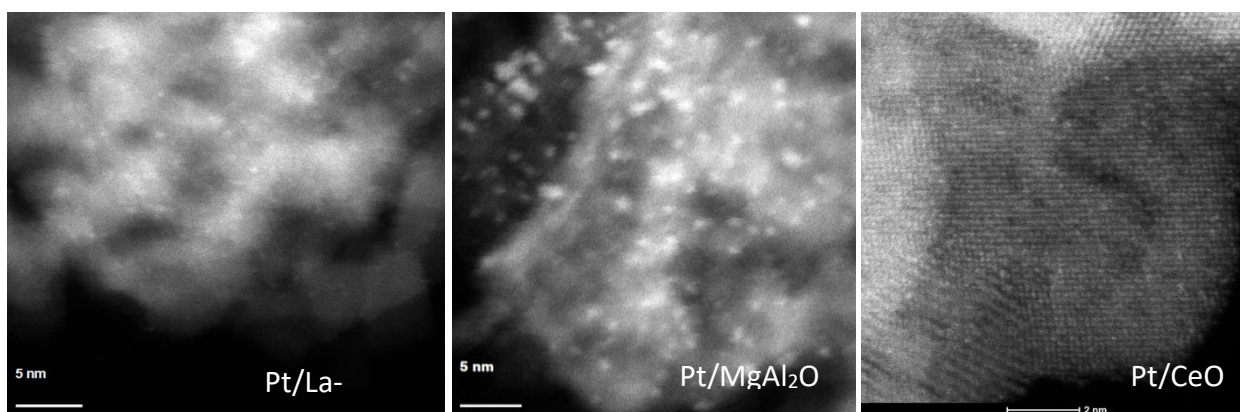


Figure 1. HAADF STEM images of 1wt%Pt on La-Al<sub>2</sub>O<sub>3</sub> (left), MgAl<sub>2</sub>O<sub>4</sub> (center) and CeO<sub>2</sub> (right) after impregnation, drying and calcination at 550°C/4h. The resulting Pt particle sizes are very different.

We have characterized these differences in catalyst supports in terms of their ability to trap atoms. We learnt that ceria supports help generate a stable and fully regenerable Pt catalyst that can change reversibly from single atoms into metallic nanoparticles [3]. The understanding of atom trapping derived from ceria supports can be translated to other oxide supports. This will impact not only automotive exhaust treatment (where catalysts are exposed to high temperature) but also other industrial reactions such as propane dehydrogenation or methane oxidation, where high temperatures are required. The presentation will focus on the understanding of atom trapping and its application for design of thermally stable and regenerable catalysts.

## References

- [1] T.W. Hansen, A.T. Delariva, S.R. Challa, and A.K. Datye, Sintering of Catalytic Nanoparticles: Particle Migration or Ostwald Ripening? *Accounts of Chemical Research*, 2013. 46(8): p. 1720-1730.
- [2] J. Jones, H.F. Xiong, A.T. Delariva, E.J. Peterson, H. Pham, S.R. Challa, G.S. Qi, S. Oh, M.H. Wiebenga, X.I.P. Hernandez, Y. Wang, and A.K. Datye, Thermally stable single-atom platinum-on-ceria catalysts via atom trapping. *Science*, 2016. 353(6295): p. 150-154.
- [3] H.F. Xiong, S. Lin, J. Goetze, P. Pletcher, H. Guo, L. Kovarik, K. Artyushkova, B.M. Weckhuysen, and A.K. Datye, Thermally Stable and Regenerable Platinum-Tin Clusters for Propane Dehydrogenation Prepared by Atom Trapping on Ceria. *Angewandte Chemie-International Edition*, 2017. 56(31): p. 8986-8991.

**Speaker Details:** Abhaya K. Datye has been on the faculty at the University of New Mexico since 1984. Abhaya received his Ph.D. in chemical engineering from the University of Michigan. He has authored 230 publications, 6 patents and has presented 162 invited lectures around the world including the Europacat at Innsbruck, Austria, Faraday Discussion at Liverpool in the UK, WE Heraeus conference in Bad Honnef, Germany, the School for Electron Microscopy at Berlin and the Taniguchi conference in Japan. His published work has received ~13,000 citations with an h-index of 61 (Google Scholar). He is a fellow of the AIChE, the Microscopy Society of America and the Royal Society of Chemistry. He is involved in international collaborations, having led the successful NSF Partnership for International Research and Education (PIRE) on Conversion of Biomass derived reactants into Fuels, Chemicals and Materials (a collaboration between faculty and researchers in the US, Denmark, Germany, Netherlands and Finland). He has also done sabbaticals at BP in the UK, at Haldor Topsoe in Denmark and extended visits to the Univ. of Poitiers in France and he was honorary professor at the University of Witwatersrand in South Africa. He has been actively involved in the North American Catalysis Society, serving as co-chair for the Denver NAM 2017, program co-chair for the Snowbird NAM 1995. He was the Chair of the Gordon Research Conference on Catalysis in 2010.