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**Catalysis Club of Philadelphia**

**Thursday January 19<sup>th</sup>, 2012**  
DoubleTree Hotel  
4727 Concord Pike Wilmington, DE 19803

**Electrocatalysis: The next frontier in catalysis for  
energy conversion and storage**

Yushan Yan  
University of Delaware

**&**

**Conductive ceramic anodes for SOFCs based on  
Infiltration**

Lawrence Adijanto  
University of Pennsylvania  
(Student Talk, 15 minutes)

**Social Hour: 5:30 PM**  
**Buffet Dinner: 6:30 PM**  
**Meeting: 7:30 PM**

**Members: \$35.00**  
**Walk Ins & Non-members: \$40.00**  
**Student & Retired Members: \$20.00**

**Menu**

**French cut Pork Chop**, Pan Roasted  
with Maple Mashed Yams, Asparagus  
& a Madeira Sauce

**Black & Blue Cajun Spiced Chicken  
Breast** over Whipped Potatoes with  
a Stilton Sauce & a touch of Fresh  
Crab

**Vegetarian:** Four Cheese Manicotti

**Vegan:** Mediterranean Purse  
Roasted Vegetables, Couscous,  
served with Ratatouille

**Meal reservations** - Please notify  
your company representative or  
Kevin Bakhmutsky  
(kbakh@seas.upenn.edu, phone:  
215.898.0056, fax: 215.573.2093)  
by **Thursday January 12<sup>th</sup>**.

Company Representatives – We  
would like to encourage you to  
make meal/meeting reservations to  
your company representative.

**Membership** - Dues for the 2011-12  
season will be \$25.00 (\$5.00 for the  
local chapter and \$20.00 for the  
national club). Dues for students  
and post-docs will be \$10.00 (\$5.00  
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Steve Harris, LyondellBasell  
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Newtown Square, PA 19073.

# Catalysis Club of Philadelphia

Thursday January 19<sup>th</sup>, 2012

DoubleTree Hotel

4727 Concord Pike Wilmington, DE 19803

## Electrocatalysis: The next frontier in catalysis for energy conversion and storage

Yushan Yan

Distinguished Engineering Professor, Department of Chemical and Biomolecular Engineering,  
University of Delaware.

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### Abstract:

Energy has been central to human civilization. The availability of cheap and abundant fossil energy has been primarily responsible for the fastest ever human progress for the past 100 years. With the depletion of fossil energy, the increase of world population, the improvement of living standard in large population centers, and the concern of the air quality and climate change, one of the grand challenges facing humanity today is to develop an alternative energy system that is clean, safe, and sustainable and where combustion of fossil fuels no longer dominates. An electrochemical conversion based energy system with electrochemical devices such as fuel cells, flow batteries, and solar hydrogen generators could provide such an alternative. For all these devices electrocatalysis plays a critical role in controlling their performance and cost, and thus their commercial viability. For proton exchange membrane fuel cells (PEMFCs) catalysts, we have explored carbon nanotubes (CNTs) as durable catalyst supports[1]. In this presentation, however, I will focus on our recent work on platinum nanotubes (PtNTs) as supportless catalysts [2]. The PtNT catalyst platform has the potential to meet the mass and specific activity targets for vehicle applications specified by the US Department of Energy. When appropriate I will compare and contrast electrocatalysis and heterogeneous catalysis and attempt to show that they share many similar concepts. I will also present our recent work on hydroxide exchange membranes (HEMs)[3] that may allow the platinum catalysts to be replaced by non-platinum-group-metals such as nickel and silver while the expensive fluorinated Nafion membrane substituted by a hydrocarbon membrane, thus drastically reducing the cost of fuel cells. I will argue that HEMs can also help electrolyzers or flow batteries for large scale solar/wind electricity storage and for solar hydrogen generation[4].

### References:

1. C. Wang, M. Waje, X. Wang, J. M. Tang, R. C. Haddon, Y. Yan 2004. Proton exchange membrane fuel cells with carbon nanotube based electrodes, *Nano Lett.* 4:345-348 (321 citations).
2. Z. Chen, W. Li, M. Waje, Y. S. Yan 2007. Supportless Pt and PtPd nanotubes as electrocatalysts for oxygen reduction reaction, *Angew. Chem. Int. Ed.* 46:4060-4063 (156 citations and Section Cover Article).
3. S. Gu, R. Cai, T. Luo, Z. Chen, M. Sun, Y. Liu, G. He, Y. Yan 2009. A Soluble and Highly Conductive Ionomer for High Performance Hydroxide Exchange Membrane Fuel Cells, *Angew. Chem. Int. Ed.*, 48: 6499-6502 (41 citations and Front Cover Article)
4. H. Luo, T. Takata, Y. Lee, K. Domen, J. Zhao, Y. Yan 2004. Photocatalytic activity enhancing for titanium dioxide by co-doping with bromine and chlorine, *Chem. Mater.* 16:846-849 (185 citations).

### Speaker Bio:



Yushan Yan is Distinguished Engineering Professor at Chemical Engineering of the University of Delaware. He received his B. S. in Chemical Physics from the University of Science and Technology of China in 1988, and his Ph.D. in Chemical Engineering from the California Institute of Technology in 1997. He studied heterogeneous catalysis at the Dalian Institute of Chemical Physics of the Chinese Academy of Sciences from 1988 to 1992 and zeolite membranes at Caltech for this PhD thesis work. He worked for AlliedSignal Inc. as Senior Staff Engineer and Project Leader from 1996 to 1998 before joining the University of California at Riverside (UCR) as Assistant Professor. He was promoted to Associate Professor in 2002 and Professor in 2005. In 2006, he was selected as one of the five inaugural University Scholars at UCR. He was appointed Department Chair in 2008 and given the title of Presidential Chair in 2010. He moved to the University of Delaware in September 2011. His research focuses on zeolite thin films for semiconductors and aerospace applications and new materials for fuel cells, energy storage and solar hydrogen generation. He received the Donald Breck Award in 2010 from the International Zeolite Association for his zeolite thin film research, and was awarded one of the 37 inaugural-round ARPA-E projects in 2009 from the Department of Energy for his hydroxide exchange membrane work. He is a Fellow of the American Association for the Advancement

of Science. He has been an inventor of a large number of issued or pending patents. Several of his patents were licensed to form startup companies, e.g., NanoH<sub>2</sub>O, Full Cycle Energy, Zeolite Solution Materials (ZSM), and OH-Energy. His research work has been widely cited in the scientific community (129 articles in Web of Science, > 5400 citations, h-index = 41 and average citation/paper = 42 and also extensively covered by technical magazines and media including New Scientist, Business Week, C&EN News, Materials Today, China Press (newspaper) and Chinese Daily News (newspaper), CNBC, CNN.com, KABC, VOA, and many other print, video and radio media.



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## Conductive ceramic anodes for SOFCs based on Infiltration

Lawrence Adijanto

Department of Chemical and Biomolecular Engineering, University of Pennsylvania

(Student Talk, 15 minutes)

### Abstract:

We have investigated a series of doped, rare-earth vanadates ( $\text{REVO}_4$ ) for application as fuel electrodes in solid oxide fuel cell (SOFC).  $\text{REVO}_4$  made with La, Ce, Pr, and Sm showed similar redox properties, although the amount of dopant that could be added depended on which RE element was used. Doping with Sr or Ca greatly increased the electrical conductivity and widened the  $\text{P}(\text{O}_2)$  stability range for the conductive phase. Doping with transition metals, such as Ni, Cu, or Co was also possible, with some of the transition metals coming out of the lattice as small metal particles under strong reducing conditions. The possible use of these materials in SOFC anodes is discussed.

### Speaker Bio:

Lawrence Adijanto is a third year PhD student, working on his doctoral research in Chemical and Biomolecular Engineering at University of Pennsylvania, in Dr. Raymond J. Gorte and Dr. John M. Vohs's research group. He received his B.S in Chemical Engineering from Purdue University in 2009. His current thesis research focuses on Solid Oxide Fuel Cells (SOFCs) anodes