

Research on TAP: Reactor allows scientists to unlock catalysts' mysteries, complexities

If chemistry is the key to better living – DuPont's claim for decades – catalysts are the key to better chemistry and the focus of research being done at the Center for Advanced Energy Studies (CAES).

Since September 2015, Dr. Rebecca Fushimi has been building a team of postdoctoral researchers at CAES to explore the potential of a new TAP reactor, a unique machine designed to gather detailed information from chemical reactions.

TAP stands for temporal analysis of products, and is the invention of Dr. John Gleaves, a professor at Washington University in St. Louis and a longtime associate of Fushimi.

There are 20 TAP reactors worldwide, but only three in the United States. One is at Harvard, the second is owned by BASF, an international chemical conglomerate, and the third is at CAES.

"It's a different way of asking questions and understanding how materials work," said Fushimi.

Catalysts are materials composed of different metals that can be used to speed up chemical reactions. Although they have been used for centuries, how they function has remained largely a mystery.

"You're trying to control a molecular level reaction from an industrial scale," Fushimi said. "What TAP does is provide extremely detailed kinetic information."

Of the three researchers working on Fushimi's team, Dr. Lu Cun Wang has the most experience with TAP reactors, first in Germany and then for six years at Harvard, where he began collaborating with Fushimi. While at Harvard, he investigated the catalytic behavior of nanoporous gold materials. At CAES, his focus has been

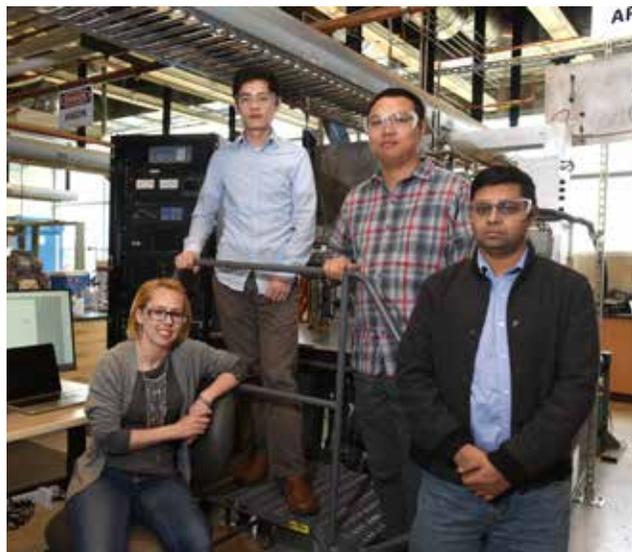
on taking surface studies and applying them to industrial-scale processes and challenges.

A typical experiment with the TAP reactor involves placing a catalyst in the center chamber. Through valves on the top, gases are shot at the catalyst. While some gas molecules bounce off, others react with the catalyst as a computer measures the time delays that result from different reaction processes. This provides insight into how different catalytic materials control the energy.

Dr. Chinmoy Baroi, who came to CAES in February from the University of Saskatchewan, is focused on modifying the TAP reactor from a high-vacuum to a high-pressure setting and seeing whether it can produce the same level results. Baroi first heard about CAES and INL at a conference in May 2015. That October, at a conference in Calgary, he met INL's Dr. Anne Gaffney, who encouraged him to apply for a postdoctoral position.

Dr. Weijian Diao, from University of South Carolina, found out about Idaho and CAES from his Ph.D. adviser, an associate of Gaffney's. His research is focused on catalyst synthesis-fabricating materials that can be tested in the TAP reactor, then analyzed. "I have to make it, then TAP gives us information about how it works," he said.

"The way we make chemicals is enormously energy intensive," Fushimi said. What she hopes to see from the TAP reactor at CAES are new catalysts that make manufacturing



Dr. Rebecca Fushimi, left, is pictured with postdoctoral researchers Dr. Lu Cun Wang, Dr. Weijian Diao and Dr. Chinmoy Baroi at the Temporal Analysis of Products reactor in CAES. (Idaho National Laboratory photo)

processes less energy intensive and less harmful to the environment.

A major driver for this will be collaborative research. Initial collaborations involve INL scientists working with researchers from University of Wyoming, but Fushimi also would like to see collaboration with the three CAES Idaho universities and have the reactor become a user facility hosting researchers from industry and academic institutions around the world.

About CAES

The Center for Advanced Energy Studies (CAES), a consortium of Idaho National Laboratory, Boise State University, Idaho State University, University of Idaho, and University of Wyoming, is a public/private research center that provides research capabilities, energy-related educational opportunities and industry assistance to fuel economic growth.

East meets WEST

Four Korean students explore work-study opportunities at CAES, UI

Four students from the Republic of Korea (South Korea) are in Idaho Falls this spring as part of the Korea WEST exchange program.

WEST stands for Work, English, Study and Travel. Begun in 2009, the program has given top South Korean university students and young professionals the opportunities to immerse themselves in everything the United States has to offer. Since 2010, 20 WEST students have come to Idaho Falls through a collaboration between the University of Idaho (UI, a member of the CAES consortium) and Cultural Vistas, a nonprofit exchange organization.

Based on interviews done at the beginning of the process and after four months of English training, Cultural Vistas assesses the students' fields of study and places them in appropriate environments.

"It's a chance for us to learn more about how things work in South Korea," said Alice Allen, who coordinates the program in Idaho Falls. "Of course we would always love to have them come back for graduate studies. We learn as much from them as they do from us."

This year's students are:

Kyounghee Jeon, 21, a chemical engineering undergraduate from Kyunghee University. After two months of research, Jeon was ready in mid-April to begin an experiment that would convert syngas, an intermediate-fuel-gas mixture consisting mainly of hydrogen and carbon monoxide, to methanol and then hydrocarbon. Her team hoped they could eliminate the need for two catalytic reactions and make the reaction happen in one. The experiment involved gas chromatography mass spectrometry. Jeon said she will be returning to school in the fall with a much greater understanding of the sophisticated technology involved with chemical engineering.

Senngje Oh, 24, a chemical engineering student from Ulsan National Institute of Science and Technology. At CAES, Oh is studying the applications of electrochemical methods in the pyroprocessing of spent nuclear fuel. While he had completed several courses in electro- and surface chemistry in South Korea, he had no previous experience with nuclear materials. "I let my



Interns in the Korea WEST program, visiting CAES and the University of Idaho this spring (from left): Kyounghee Jeon (chemical engineering), Jaemyun Lee (electrical engineering), Senngje Oh (chemical engineering) and Yumin Kwak (communications). (Idaho National Laboratory photo)

sponsor know my interest and they chose this (internship) for me," he said. What interests him most is America's research infrastructure. Although he is required to return to South Korea when his visa is up, Oh said he is interested in returning to the United States to pursue graduate studies.

Jaemyun Lee, 27, an electrical engineering student from Kyungpook National University in Daegu, his home city. Lee has been learning about hybrid energy systems that take heat from nuclear reactors and direct it toward other applications, such as fuel processing, water desalinization and electrical generation. It has improved his understanding of nuclear power plants, a field he may go into when he returns to South Korea.

Yumin Kwak, 23, an advertising major from Hanyang University in Seoul, South Korea's capital. Although familiar with Adobe PhotoShop, she has gained exposure with Adobe Illustrator and Prezi, taking on such projects as the April 30 Disc Golf Scramble poster and word clouds. She has one semester left after she returns home, after which she would like to come back to the United States.

Although Korea WEST visits can be as long as 18 months, the four participants in Idaho Falls are in the U.S. for the shortest duration, six months. Their visits started with two months training in English fluency. Jeon and Lee studied in Washington, D.C., Oh studied in San Diego and Kwak studied in New York City.

Jeon, Oh and Lee have been under the supervision of UI's Haiyan Zhao, a CAES-affiliate researcher, while Kwak has been performing communications tasks for UI Student Services under Carol Baldwin and Ryan Haworth.

DID YOU KNOW?

- The 2018 Winter Olympics are slated to be held in South Korea.
- South Korea's total population in 2015 was estimated at 50.6 million.
- The flag of South Korea is known as the Taegukgi (literally "Taeguk flag").

Lab-Corps programs seek to foster entrepreneurial spirit in lab

For researchers in America's national laboratory system, guiding a brilliant innovation to commercial or industrial use can sometimes be the most daunting challenge of all.

The U.S. Department of Energy's Lab-Corps program, sponsored by the Office of Energy Efficiency and Renewable Energy (EERE), offers a new approach by getting scientists to look beyond the nuts and bolts of their research and explore new ideas for meeting industrial users' needs. Announced in autumn 2014, the goal of Lab-Corps is to build an entrepreneurial culture at national labs by cultivating collaboration between researchers and private entrepreneurs.

"The program is building commercialization into the DNA of our researchers," says Tammie Borders, Lab-Corps leader for Idaho National Laboratory, one of seven laboratories participating in the pilot program.

INL launched two Lab-Corps entrepreneurial teams in the fall of 2015, both consisting of a principal investigator, an entrepreneurial lead, and an industry mentor. Each is responsible for bringing a clean energy technology to market by following guidelines based on customer interactions and market feedback. Each team meets face-to-face with customers to determine key resources, plus activities and partners needed to bring business ideas to marketplace.

According to Borders, the effort also aims to make national laboratories more accessible to businesses.

On one team, INL researchers Aaron Wilson and Carter Fox are proposing a Switchable Polarity Solvent Forward Osmosis (SPS FO) technology that has the potential to have a huge impact on water purification and oil and gas exploration. On the other, researcher Matthew Balderree has developed an application

that guides unmanned aircraft as they inspect wind turbine blades, cutting downtime at wind farms.

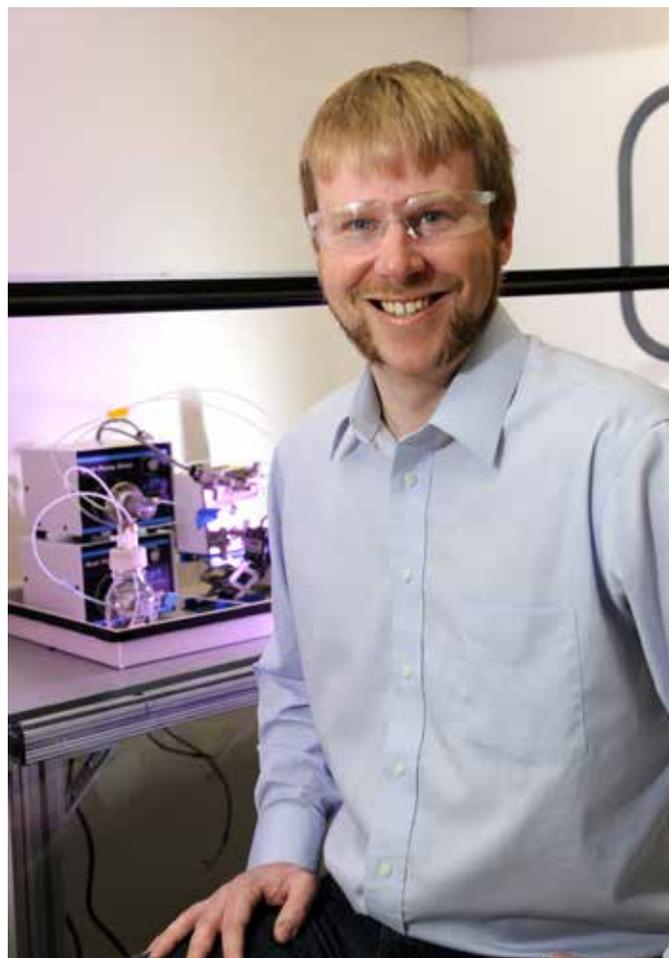
This spring more teams were announced. One involves nuclear energy in seismic analysis, with Justin Coleman as principal investigator, Chandu Bolisetti as entrepreneurial lead and Mark Kaczor from the INL Tech Deployment office as industry mentor.

The second involves a bioenergy high-moisture pelleting process, with Jaya Tumuluru as principal investigator, Erica Belmont of the University of Wyoming serving as entrepreneurial lead and Tech Deployment's Art Baker as industry mentor.

INL is one of two Lab-Corps pilot participants based in a rural area. In that respect, it is taking on the unique challenges associated with smaller business markets.

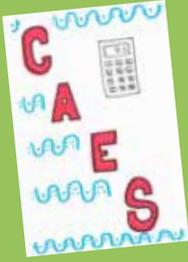
By building relationships, working with customers and consulting industry experts, researchers can watch their original ideas evolve and transform.

Lab-Corps could have a profound effect on DOE's future direction. "The goal is to strengthen the nation's global competitiveness and advance clean energy performance," said CAES Director and INL Associate Director Steven Aumeier.



Dr. Aaron Wilson, pictured with Switchable Polarity Solvent Forward Osmosis, is a member of one of the first Lab-Corps teams out of INL. (Idaho National Laboratory photo)

The Lab-Corps teams at Idaho National Laboratory have an advantage by being managed through the Center for Advanced Energy Studies. CAES's involvement allows the INL teams to tap into such resources as Idaho State University's Small Business Development Center, Brigham Young University-Idaho's Entrepreneurial Center and Boise State's University Venture College, as well the Technology Deployment team at INL.



Middle schoolers from Bonneville School District 93 visited CAES on March 28 and learned about the Computer-Assisted Virtual Environment (CAVE), Heavy Vehicle Simulator, and how to engineer earthquake-resistant structures.

Here are some excerpts from the thank-you cards that came the next week (some spelling corrections have been made):

“I am a girl who hates science; you surely made it sound fun!”

– An Ammon 6th-grade student

“I learned that when you are building something that you never give up, you keep trying, and you always work together on engineering.”

– Kilee

“Today I learned all of the different engineers! I only thought there was one kind! Imagine that, more than one! Ha, ha! Thank you once again!”

– Kaytlynn

CALENDAR

MAY 17-18

Wyoming Unmanned Aerial Vehicles Symposium

Marian H. Rochelle Gateway Center, Laramie, Wyoming

MAY 18-20

Advances in Structural and Chemical Engineering Workshop

Boise State University, Boise, Idaho

JUNE 12-14

Renewable Energy Summit

University of Wyoming, Laramie, Wyoming

JULY 26-27

CAES Industry Water-Energy Workshop

INL Energy Innovation Laboratory, Idaho Falls, Idaho

AUGUST 9-10

Intermountain Energy Summit:

Innovations and Opportunities in Clean Energy

Shilo Inn and Suites, Idaho Falls, Idaho

AUGUST 25-26

Second Annual Snake River Geothermal Meeting

INL Energy Innovation Laboratory, Idaho Falls, Idaho

Visit the CAES online calendar for more details

on each event: <https://caesenergy.org/newsroom/calendar/>

CAES by the Numbers

(October 2015-March 2016)

766

visitors toured CAES

1,286

Visitors experienced the Computer-Assisted Virtual Environment (CAVE)

718

Science, Technology, Engineering and Math (STEM) outreach visitors learned about CAES research

16-50155-01-R6

Have comments, questions or suggestions for future newsletter topics?
Contact Julie Ulrich, julie.ulrich@inl.gov, 208-526-1572.

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