Argonne NATIONAL LABORATORY

Transportation Technology R&D Center

Volume 9, No. 2
Fall 2009

TransForum

News From Argonne's Transportation Technology R&D Center
www.transportation.anl.gov

RESEARCH REVIEW

Argonne, Korea's KATECH Partner on Green Car Technologies 2

Argonne's Lithium-ion Battery Research Produces New Materials and Technology Transfer Successes 3

Transportation Technologies Shine at Argonne's Open House 6

Argonne Involved in Naperville's Proposed Green Fuels Depot 7

TTRDC Now Equipped with "X-ray Vision" 8

Making the Power Grid Smarter 10

Low-temperature Combustion Knocks Out NO_x, Saves Fuel and Money 11

PHEVs Need Further Research for Acceptable Payback 12

Eco-engineers from The Ohio State University Win Gold at 2009 EcoCAR Competition 13

Energy Frontier Research Centers Promise Advances in Transportation Technologies 14

Air Force Fellows Help Work Toward Smarter Diesel Engines 16

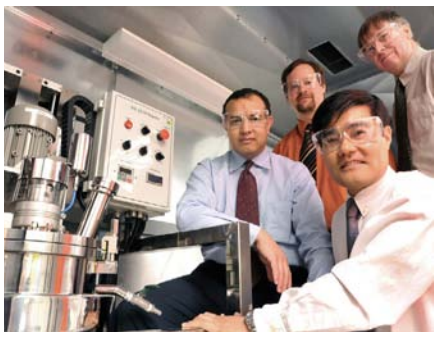
Interns Play an Important Role in Argonne's Transportation Research 18

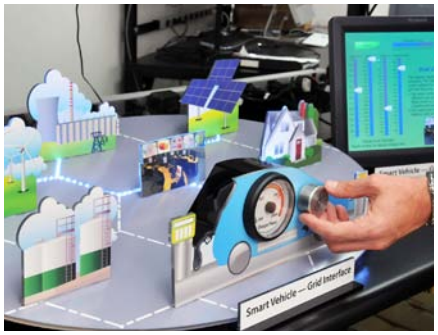
Facility Spotlight: Fourier Transform Infrared Spectrometer 20

IN THE NEWS 21

FASTRAX 22

PUTTING ARGONNE'S RESOURCES TO WORK FOR YOU 24





U.S. DEPARTMENT OF ENERGY

A U.S. Department of Energy laboratory managed by UChicago Argonne, LLC

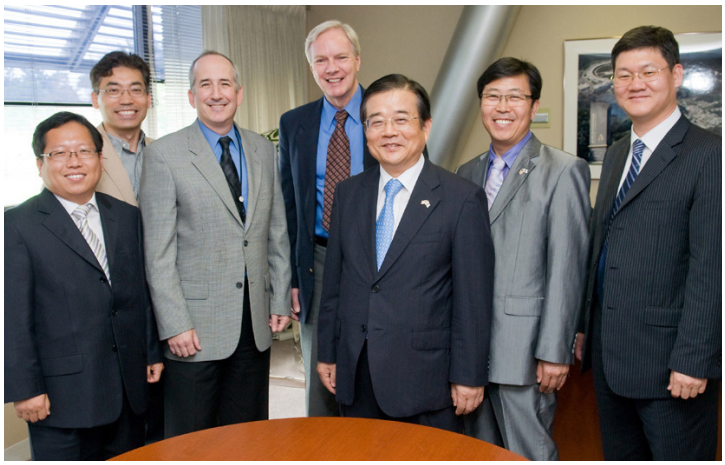
Argonne, Korea's KATECH Partner on Green Car Technologies

Argonne's Transportation Technology Research and Development Center (TTRDC) now has another international partner in its efforts to take automotive technologies to new heights. On May 16, 2009, Argonne entered into a memorandum of understanding (MOU) with the Korea Automotive Technology Institute (KATECH). Steven Chu, the U.S. Department of Energy Secretary and Lee Youn-Ho, the Korea Ministry of Knowledge Economy Minister, were present at the signing.

The goal of this agreement is to accelerate the development and commercialization of a variety of green car technologies. This collaboration will focus on three key areas of research:

- Clean diesel combustion and emissions control
- Renewable biofuels testing and protocol development
- Electric-drive vehicle benchmarking and battery systems testing

"Both parties will be doing parallel research and sharing results," said Kyeong Lee, a principal mechanical engineer in Argonne's TTRDC. "This will increase our knowledge base and help speed along the R&D process."



From left to right: Director Sung-Jin Choi, Vehicle Platform Research Center, KATECH; Mechanical Engineer Kyeong Lee, Argonne TTRDC; Laboratory Director Eric Isaacs, Argonne; Director Larry Johnson, Argonne TTRDC; President Ki-Sub Lee, KATECH; Director Chun-Boom Lee, Environmental System R&D Center, KATECH; and Director Baek-Haeng Lee, Electron System R&D Center, KATECH.

KATECH is the South Korean transportation research and development counterpart of Argonne's TTRDC. The two organizations will team up by initiating joint research projects, information exchanges of publicly available research data, collaborative visits and staff exchanges.

"Both the U.S. and South Korea share a common problem—heavy dependence on foreign oil," added Larry Johnson, TTRDC director. "Technology transfer of our results will help the auto industries in both countries improve the energy efficiency of their vehicles."

Following the MOU signing in Washington, DC, the president of KATECH and several staff visited Argonne's transportation facilities on May 17, 2009, as both teams continued discussions on the initial projects.

Both Argonne and KATECH bring unique resources and expertise to the table. For example, KATECH's facilities will help increase Argonne's testing capabilities. These facilities include:

- Heavy-duty engine dynamometers with an integrated hardware-in-the-loop system,
- Nanoparticle measurement systems, and
- Medium-duty four-wheel independent chassis dynamometer.

This is not the first MOU for Argonne's TTRDC. In 2004, the lab signed an MOU with the China Automotive Technology and Research Center (CATARC) to help foster the commercialization of energy-efficient vehicle technologies and clean transportation fuels in China. While the MOU with China is more of an analysis and assessment collaboration, the KATECH MOU will focus on the research and development of new transportation technologies.

For more information, contact
Larry Johnson
630.252.5631
johnson@anl.gov

Argonne's Lithium-ion Battery Research Produces New Materials and Technology Transfer Successes

Argonne's highly regarded battery research was recently recognized for three significant accomplishments in the development of new battery materials and the transfer of Argonne-developed advanced high-energy cathode and processing technologies to the private sector. According to Argonne Director Eric Isaacs, "These battery research accomplishments have the potential to put the United States several steps closer to reaching President Barack Obama's goal of putting more than one-million plug-in hybrid electric vehicles on the road by 2015."

Argonne researchers (left) Zonghai Chen, Khalil Amine and Ilias Belharouak won an Excellence in Technology Transfer Award for a battery system expected to help reduce greenhouse gas emissions and America's dependence on imported oil.

Argonne-EnerDel Battery Partnership Wins Tech Transfer Award

Argonne scientists Khalil Amine, Ilias Belharouak and Zonghai Chen won an Excellence in Technology Transfer Award from the Federal Laboratory Consortium for Technology Transfer for their work with EnerDel, Inc., on a very high-power battery system for hybrid electric vehicles (HEVs). This nano-lithium titanate-based battery technology also won an R&D 100 Award in 2008.

Funded by EnerDel, Inc. under the United States Advanced Battery Consortium (USABC) program, the Argonne-developed system has the potential to meet most of the USABC requirements for HEVs. The technology has enormous commercial potential because it enables the development of safe, long-lasting high-power batteries for HEVs. EnerDel gave the Argonne researchers one year to conduct the research in support of the company's two-year commercialization goal.

Benefits of the new Li-ion battery include:

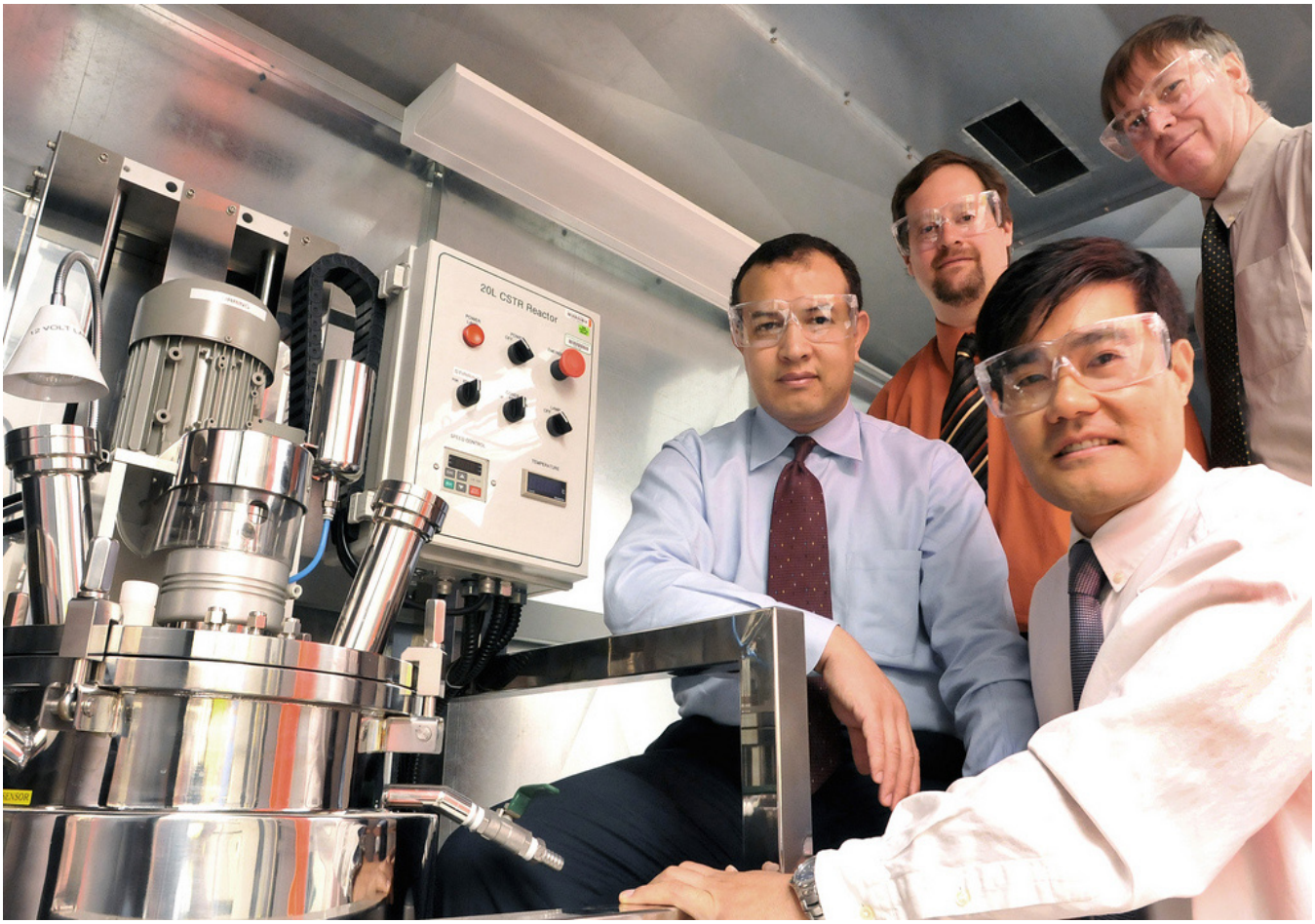
- Long cycle life
- Unmatched safety performance compared to other Li-ion battery technologies
- Resistance to overheating during high-rate cycling
- 5-kilowatt cold cranking at -30 °C
- Highest power ever reported in a Li-ion battery, when combined with a lithium manganese spinel
- Reliability
- Low cost

Argonne developed the technology under a Work-for-Others agreement. The U.S. Department of Energy (DOE) Vehicle Technologies Program provided precompetitive research funding.

BASF to Produce and Market Argonne-developed High-energy Composite Cathode Materials

Continuing the theme of transferring DOE-funded research from lab to market, Argonne and BASF (the world's largest chemical company) signed a global licensing agreement that enables BASF to produce and market Argonne's composite cathode materials to manufacturers of advanced Li-ion batteries. The patented cathode materials and the process for making them are licensed to BASF as part of a diverse suite of Li-ion battery inventions and patents developed at Argonne, with funding from DOE's Vehicle Technologies Program.

"Battery" from page 3



Argonne National Laboratory battery researchers (left) Khalil Amine, Chris Johnson, Sun-Ho Kang and Michael Thackeray flank a continuously-stirred tank reactor used to produce scaled-up quantities of cathode materials for lithium-ion batteries. Argonne's lithium-ion battery technology will be commercialized by chemical company BASF under a licensing agreement.

The advancement and commercialization of the Argonne-developed cathode materials will result in batteries that perform better, last longer and are safer than today's Li-ion batteries, which is critical for the advancement of plug-in hybrid electric vehicles (PHEVs) and electric vehicles (EVs).

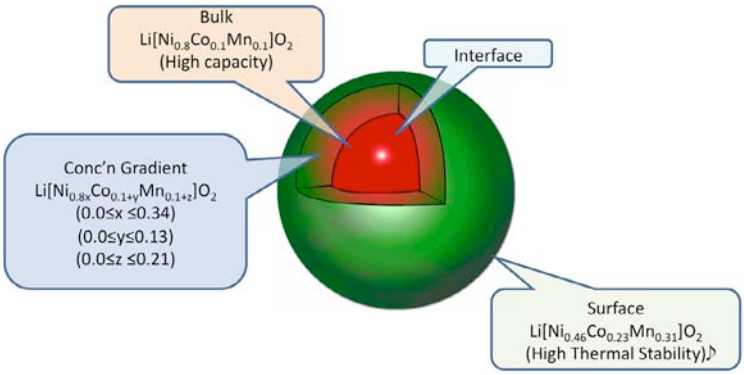
Argonne's composite cathode materials incorporate a unique combination of lithium- and manganese-rich mixed-metal oxides. Manganese enhances the structural and thermal stability of the electrode, which increases battery safety, according to Michael Thackeray, Argonne Distinguished Fellow and director of the Center for Electrical Energy Storage at Argonne. Manganese is also more abundant and less toxic than cobalt or nickel.

Enhanced stability also permits battery systems to charge at a higher voltage, resulting in much greater energy storage capacity than exists in today's cathode materials—an especially important consideration for vehicular applications.

"Argonne's technology offers a 50–100 percent increase in energy storage capacity over conventional cathode materials," says Thackeray. "In short, it offers the longest-lasting energy available in the smallest, lightest package." In addition, "Argonne's composite cathode materials exhibit outstanding safety characteristics compared to other layered metal oxide cathodes and have the potential to meet the energy requirements for a 40-mile, all-electric range PHEV," according to Khalil Amine, Argonne senior scientist and leader of the Battery Technology group.

"This licensing agreement has tremendous potential," says Stephen Ban, Director of Argonne's Office of Technology Transfer. "BASF's ability to make these advanced materials widely available will significantly advance the penetration of next-generation lithium-ion batteries into the U.S. marketplace."

BASF will conduct further Li-ion battery material application development. It plans to build one of North America's largest cathode material production facilities in Elyria, Ohio.



Schematic diagram of positive-electrode particle with Ni-rich core surrounded by concentration-gradient outer layer.

Global Partnership Produces Safer, Longer-lasting Cathode Material

Researchers at Argonne and Hanyang University in South Korea have developed a new high-energy cathode material that greatly increases the safety and extends the lifespan of Li-ion batteries. This new cathode material is based on a layered lithium nickel cobalt manganese oxide. Each particle has a central bulk that is rich in nickel (Ni) and a manganese-rich (Mn-rich) outer layer, with decreasing Ni concentration and increasing Mn and cobalt (Co) concentrations as the surface is approached. The former provides high capacity, while the latter improves thermal stability.

The transitional nature of the new material's composition makes it more functional. Says Argonne's Khalil Amine, "The high-energy material we developed makes up a new class of oxide materials in which the composition of each particle changes from the bulk to the outer layer. Most oxide cathodes have a uniform composition throughout each particle, and offer low capacity and high surface reactivity with the electrolyte." The new material's characteristics greatly improve the life and safety of lithium battery materials, while offering very high-energy characteristics for possible use in PHEVs.

"The material has also demonstrated a very high power capability," said Yank-Kook Sun, co-principal investigator and a professor in the Department of Chemical Engineering at Hanyang University. "We are able to charge the material to 4.3–4.4 volts and attain a very high capacity of more than 210 milliampere hours per gram (mAh/g), with good power capability," he said. "Conventional cathodes have a capacity of 140 to160 mAh/g."

Argonne National Laboratory works with DOE's Office of Vehicle Technologies to develop advanced anode and cathode materials and improve very high-energy lithium-ion (Li-ion) battery technologies for transportation applications. When used in light-duty vehicles, very high-energy batteries will help reduce greenhouse gas emissions and America's dependence on imported oil.

For more information, contact
Khalil Amine
630.252.3838
amine@anl.gov

Stephen Ban
630.252.8111
sdban@anl.gov

Transportation Technologies Shine at Argonne's Open House

On Saturday, August 29, 2009, Argonne National Laboratory hosted 22,000 visitors at a community open house, the first since 2006. Many of the guests visited the Transportation Technology Research and Development Center's tent where they could participate in more than 15 interactive exhibits, hands-on demonstrations and engaging presentations about Argonne's research into emerging technologies that will help make next-generation vehicles a reality.

Researcher Forrest Jehlik shows open house visitors how to use Argonne's driving simulator.

Exhibits

Visitors were able to

- See clean diesel fuel made from wood, coal and yard waste;
- Examine shredder residue from recycled automobiles such as foam, plastic and various metals;
- Drive an advanced vehicle using a simulator; and
- Calculate their "carbon footprint" (or greenhouse gases they produced) based on the miles they traveled to get to the open house and the vehicle used.

Salil Arora (left) explains the Carbon Calculator exhibit to visitors including Argonne Laboratory Director Eric Isaacs.

Advanced technology vehicles and a test platform were also on display, including the

- *GT1 Chevrolet Corvette*—This ethanol-fueled vehicle finished first in the GT1 Grand Touring Class and tenth overall in the American Le Mans Series (ALMS) Green Challenge, an energy-efficient, environmental race.
- *TTR (Through-The-Road) Hybrid*—This parallel hybrid electric vehicle is a test platform for evaluating plug-in hybrid electric vehicle components.
- *Opel Astra*—This vehicle is used to test Argonne-developed clean diesel fuels.
- *EcoCAR - 2009 Saturn Vue*—This car is being used in EcoCAR: The NeXt Challenge, a three-year advanced vehicle technology engineering competition for college students.
- *MATT (Modular Automotive Technology Testbed)*—This Argonne-developed test platform is used to evaluate a variety of advanced vehicle technologies and components.

2009 Open House Web site:
www.transportation.anl.gov/features/2009_ttrdc_openhouse.html

Argonne Involved in Naperville's Proposed Green Fuels Depot

Using grass clippings to power next-generation vehicles—now that's green transportation!

This is one of the ideas being considered at Naperville's newly proposed Green Fuels Depot. The project, which will require $4 million in funding to get started, would bring together Argonne National Laboratory, the city of Naperville, Illinois, Packer Engineering, Naperville, and the College of DuPage, Glen Ellyn, Illinois, for an innovative plan to produce renewable energy.

"It's a golden opportunity for Argonne to be associated with one of our neighboring communities in promoting new technologies that we have pioneered here at the Laboratory," said Glenn Keller, vehicle testing activities manager in Argonne's Center for Transportation Research.

The proposal calls for the development of a system capable of converting municipal landscape waste into one of three green energy sources: ethanol, bio-electricity or hydrogen. The ultimate goal will be for the depot to supply power to Naperville's vehicle fleet.

"There is a unique, refreshing twist to this proposal," Keller said. "It's a utopian vision to have this closed loop circuit, where a city can turn its own yard waste into fuels that will benefit their community."

Argonne will use its expertise and resources in biofuels processing and advanced vehicle technologies to characterize and evaluate the three green fuel choices before Naperville deploys them. The Laboratory will also aid in the development of advanced vehicles that can use these renewable energy sources, namely plug-in electric vehicles (PHEVs) and hydrogen fuel cell vehicles.

The Depot will use a gasifier from Packer Engineering to convert grass, leaves, branches and other biomass into syngas, a gas mixture that contains carbon monoxide and hydrogen. The syngas can then be used to create cellulosic ethanol, bio-electricity or hydrogen. Although the proposal calls for trying all three fuel types, Keller said it would be more practical to concentrate on producing just one fuel in a real-world application.

Argonne would also be contributing to the ethanol conversion process. The Laboratory has already investigated the use of anaerobic bacteria to make ethanol from syngas. The process is particularly appealing because of its high energy efficiency.

Naperville's fleet currently includes flex-fuel vehicles that run on both gasoline and ethanol, so the ethanol could be put to use immediately. The project will also focus on using syngas to produce green electricity for charging PHEVs and a hydrogen separation and storage process that could be used to fill-up fuel cell powered vehicles.

This pilot project will use only 3 percent of the annual landscape waste collected by the city. If all 48,000 cubic yards of Naperville's landscape waste were used in a full-scale Green Fuels Depot, it would be enough to fuel all 300 vehicles in the city's fleet. However, the small fraction being used would still supply enough:

- bio-electricity to power five PHEVs running for eight hours a day,
- ethanol to run seven flex-fuel vehicles for 300 miles of driving a day, or
- hydrogen to power nine polymer electrolyte membrane fuel cell vehicles with a 300-mile range.

U.S. Rep. Judy Biggert (R-IL-13th) has requested $4 million in federal funding to get the project started. It will require another $3.8 million in the second year. Through this partnership, the participants hope their findings will serve as a model for other cities across the country. The potential benefits of these Green Fuel Depots include reducing our dependence on petroleum, reducing greenhouse gas emissions and creating a new market demand for green jobs.

For more information, contact
Glenn Keller
630.252.2028
gkeller@anl.gov

TTRDC Now Equipped with "X-ray Vision"

Engineers at Argonne's Transportation Technology Research and Development Center (TTRDC) now have another invaluable research tool at their disposal—regular access to the brightest X-ray beams in the Western Hemisphere.

In March 2009, TTRDC researchers began conducting research at their new permanent beamline at Argonne's Advanced Photon Source (APS), a national synchrotron X-ray research facility funded by the U.S. Department of Energy (DOE). The TTRDC was able to secure this research space with funding from the DOE's Office of Vehicle Technologies and Office of Basic Energy Sciences.

The powerful X-ray beams created by the APS can penetrate materials to reveal details that cannot otherwise be seen. Currently, Argonne transportation researchers are using this tool to peer inside liquid sprays from fuel injectors for diesel engines.

"The physics of sprays are still not very well understood," said Christopher Powell, an engine research scientist at Argonne. "With the X-ray beam, you can measure exactly how much fuel is in the spray at any given time."

With a greater understanding of fuel spray composition, researchers have the ability to manipulate sprays to improve fuel efficiency and reduce harmful emissions.

Engine research engineer Christopher Powell fits a specially designed X-ray pressure window to a high-pressure chamber used in diesel spray research.

Mechanical engineer Alan Kastengren examines a diesel injection nozzle used in Argonne's X-ray fuel spray research.

"The way in which the fuel is distributed has the biggest impact on fuel efficiency. It's one of the few variables you have to play with in a diesel engine," Powell said.

TTRDC researchers have been using the APS to study fuel injectors and sprays for the past decade. However, their research time was limited to about six weeks per year. Now they can perform X-ray studies year-round.

"The biggest advantage of having a permanent space here is that it gives us easy access to this unique tool and allows us to expand our collaborations with industrial partners," Powell said.

Industry Excitement

Over the last 10 years, Robert Bosch GmbH, the world's leading producer of fuel injection equipment, has collaborated with Argonne on a wide variety of injection research projects. Bosch researcher Philippe Leick believes that Argonne's spray research can help improve engine development by providing a more detailed understanding of the fuel injection system. This is a crucial component for diesel engines, as the atomization of the fuel jet and its subsequent propagation, evaporation and combustion are strongly affected by the nozzle and injector designs.

"Compared to other experimental techniques, which only scratch the surface of the diesel spray, X-ray radiography is unique because it shows us what is going on inside the spray," Leick said.

"Argonne is in an exceptional position among research laboratories because it offers both the extremely bright synchrotron X-ray source needed for these experiments and has a team of highly qualified, experienced engineers and physicists dedicated to engine research," he added.

David L.S. Hung, currently an associate professor of mechanical engineering at Michigan State University and previously a technical fellow at Visteon Corporation, has been collaborating with Argonne researchers at the APS since 2004 to investigate fuel injector spray characteristics. He said the facility has helped reveal critical fuel atomization phenomena such as the fuel breakup and evolution of emerging jets from high turbulence injection nozzles.

Christopher Powell aligns an X-ray beam tube at the Transportation Research Beamline.

"The contributions of this collaborative effort have made a significant impact to the automotive fuel injector industry by allowing engineers and researchers to design cleaner and better fuel injectors and to meet the demands of more challenging fuels such as bioderived and alternative fuels," Hung said.

First Research Project

In June, Powell and his colleagues completed the first set of experiments at their new beamline. In a collaborative effort with Sandia National Laboratory and The University of Wisconsin-Madison's Engine Research Center, scientists used the beamline to capture detailed images of sprays from a fuel injector on loan from Sandia. As part of the project, Nidheesh Bharadwaj, a Ph.D. student from the University of Wisconsin, spent five weeks assisting researchers at Argonne.

Powell said the objective of the work is to improve computational models of sprays and engines, and to help engine and injection manufacturers make more efficient automobiles.

Sandia researchers have already completed visible light imaging and combustion measurements on the same injector, so there is a wealth of data to work with. The University of Wisconsin will use the results to develop new and improved computational models.

Powell said these improved models could save automakers a lot of time and money by streamlining the engine design process, which currently relies heavily on trial and error.

The initial APS experiments are not complete yet, but Powell expects the collaborative project to be finished sometime later this year.

Looking Ahead

Other projects are already looming on the horizon for TTRDC's new research space. Plans include using the X-rays to explore injectors that are used in Argonne's continuing research into low-temperature combustion. This project will use injectors and operating conditions that match those being used in Argonne's engine research lab, with the goal of linking the structure of sprays with engine performance and emissions.

Argonne will also team with Sandia as part of the Engine Combustion Network. Sandia is distributing 10 identical injectors to research organizations around the world to compile a broad data set on one injector. Upon completion the data will be made freely available on the Web.

For more information, contact
Christopher Powell
630.252.9027
powell@anl.gov

Making the Power Grid Smarter

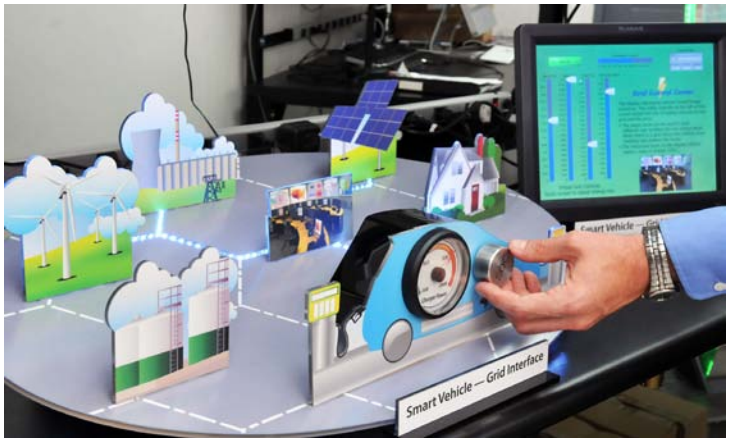
As the "smart" power grid moves from concept to reality, Argonne National Laboratory is helping to ensure this technology will interact seamlessly with the emergence of plug-in hybrid electric vehicles (PHEVs).

The smart grid involves updating the existing power grid to employ real-time, two-way communication technologies that allow consumers to connect directly with power suppliers. This will give consumers the ability to choose where their electricity comes from and when they want it delivered.

In addition to helping people save money and help the environment, the smart grid will also be a big help to electricity providers. By giving utilities real-time information about where power is needed and what energy sources are available, they can route power more efficiently without overloading the grid.

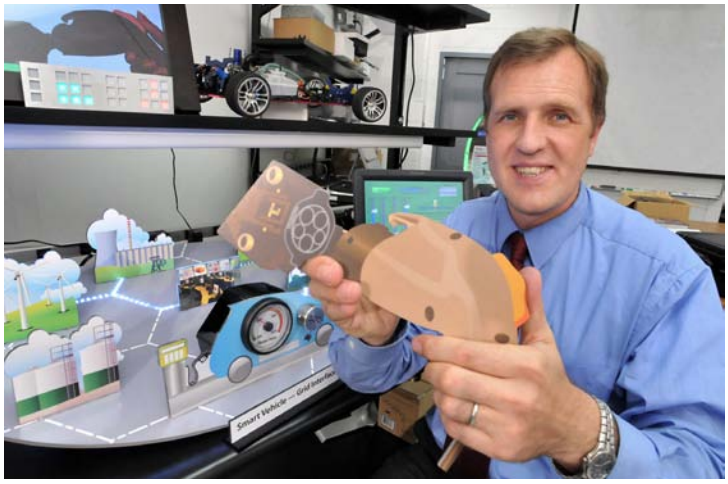
The smart grid is a key element of President Obama's plan to lower energy costs for consumers, achieve energy independence and reduce greenhouse gases. And with President Obama's goal to have one million PHEVs on the road by 2015, a smarter grid also becomes increasingly important for managing the added electricity demand created by these next-generation vehicles.

An important component of integrating PHEVs into the grid will be the vehicle's plug. Ted Bohn, a principal engineer at Argonne, is active in the international committee working to develop the Society of Automotive Engineers' (SAE) new connection standard called J-1772. The group is defining this standard so manufacturers can build compatible connectors and vehicle sockets that will support both charging and two-way communication.



Argonne transportation researchers created this interactive model to demonstrate how the smart grid interacts with different types of consumers.

"Communication is what allows a charger to be a smart charger," Bohn said. "It's not simply a plug-in and turn-on charger like a cell phone charger. The smart charger allows you to charge your vehicle at a rate that is bargained between the consumer and the grid."



Argonne engineer Ted Bohn holds a mock-up of the hybrid electric vehicle (PHEV) plug. This connector will facilitate both charging and communication.

To illustrate how this process works, Bohn and his colleagues at Argonne created an interactive smart grid model for demonstration purposes. In May 2009, Bohn presented Argonne's smart grid model to international audiences at the 24th International Electric Vehicle Symposium in Stavanger, Norway, and at Test Site Sweden's Tech Transfer Conference in Gothenburg, Sweden.

The model shows how different types of consumers could interact with the smart grid. For example, a frugal customer may wait until off-peak hours to charge a PHEV because it is cheaper, while an environmentally-conscious customer may pay more to get their electricity from wind power instead of coal.

For more information, contact
Ted Bohn
630.252.6592
tbohn@anl.gov

Low-Temperature Combustion Knocks Out NO_x, Saves Fuel and Money

One of the hottest concepts in clean diesel technology is low-temperature combustion (LTC).

Engineers from Argonne's Transportation Technology Research and Development Center (TTRDC) are exploring LTC as a means to reduce nitrogen oxide (NO_x) and particulate matter (PM) emissions, and lessen the need for expensive aftertreatment devices.

The idea behind LTC is to avoid creating harmful diesel emissions by reducing the combustion temperature from 3,000 degrees Kelvin to less than 2,000 degrees Kelvin.

"NO_x formation is exponentially dependent upon flame temperature," said Steve Ciatti, a mechanical engineer in Argonne's TTRDC.

With stringent U.S. Environmental Protection Agency regulations in place for diesel engine emissions, automakers have a particular interest in innovative solutions like LTC.

Low-temperature combustion is not an entirely new concept, but most approaches come with engine performance problems. Ciatti and his fellow researchers are defining optimal LTC conditions that will result in very low outputs of NO_x and PM, while retaining high engine efficiency and a reasonably high power density.

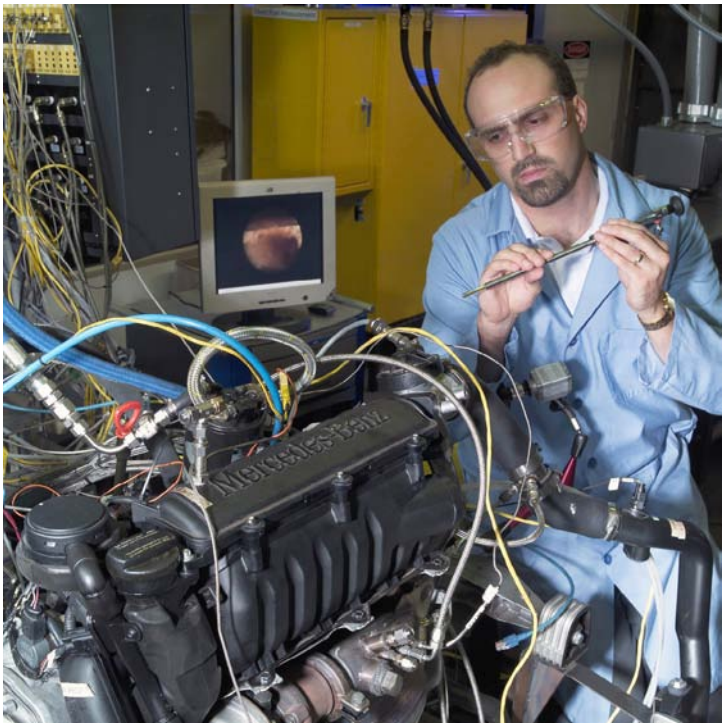
"This project definitely has the potential to be game-changing because the fuels being considered are not much different from what refineries currently produce. The potential to eliminate, or at least significantly reduce, the need for NO_x aftertreatment is very high," Ciatti said.

Current aftertreatment tools—diesel particulate filtration systems for PM and catalysts for NO_x—use fuel as the working chemical to clean the PM filter and fuel or urea to reduce NO_x. Therefore, LTC will also have a positive impact on fuel efficiency.

"This will result in a large cost savings compared to current aftertreatment devices and will improve efficiency because the fuel will not be needed as a feedstock to regenerate PM or NO_x aftertreatment devices," Ciatti said.

Argonne is developing a low-temperature combustion system that will enable Premixed Charge Compression Ignition (PCCI). In this approach, injection timing is used in combination with fuel properties, so ignition timing and combustion can be controlled more easily.

Detailed combustion information is needed to arrive at optimal LTC conditions. Ciatti and his colleagues are using endoscopes, advanced cameras and fiber-optic tools to obtain images and videos of fuel spray characteristics and combustion reactions and temperatures. In the future, researchers plan to use the powerful X-ray beams at Argonne's Advanced Photon Source to capture even more detailed images of fuel sprays.



Mechanical engineer Steve Ciatti readies an endoscope to capture diesel emissions images.

Ciatti is also validating engine and test cell hardware and software to ensure proper engine operation and control when using gasoline-like fuels. He expects to have some preliminary results this fall.

Argonne is working with General Motors, BP, ConocoPhillips, the University of Illinois at Chicago and the U.S. Air Force to develop this technology into a usable system for automobiles.

Research funding is provided by the U.S. Department of Energy's Office of Vehicle Technologies under Gurpreet Singh.

For more information, contact
Steve Ciatti
630.252.5635
ciatti@anl.gov

PHEVs Need Further Research for Acceptable Payback

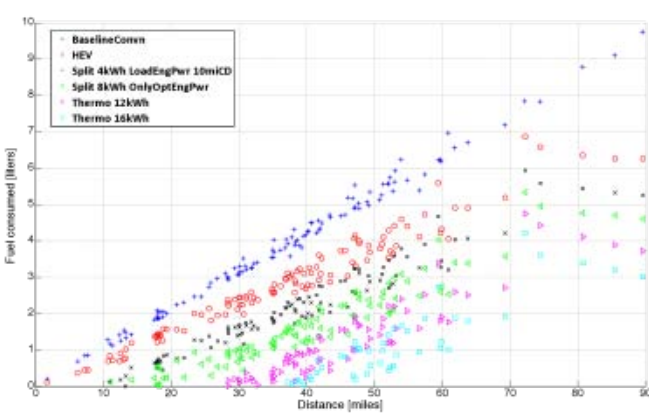
Aymeric Rousseau and his team at Argonne studied the impact of real-world drive cycles on the fuel efficiency and costs of different plug-in hybrid electric vehicle (PHEV) configurations. They found that while different PHEV configurations all demonstrated great potential for replacing gasoline (with less gasoline consumed as more electricity was used), the benefit of adding a larger battery seemed to decrease with increasing battery pack size.

"In general, the larger the battery, the more fuel saved," said Rousseau, principal investigator of the vehicle modeling and simulation group. "But with every increase in battery energy, there was no proportional decrease in fuel consumption."

The study used Argonne's Powertrain System Analysis Toolkit© (PSAT) for test simulation. The battery power was sized to follow a specific all-electric mode driving cycle to meet the all-electric range (AER) requirements. Results showed that the fuel saved by going from 4 to 8 kilowatt-hours (kWh) was much greater than the fuel saved going from 12 to 16 kWh (see chart below).

Battery energy use improved with the smaller batteries. For the 4kWh battery, 100 percent of the usable stored energy was consumed by the vehicle. While using the 8kWh battery, only 93 percent of the available energy was consumed. Some available energy remained for the larger batteries due to shorter trips. However, the vehicle continued to carry the battery energy that was not used, and the added weight of the larger battery impacted the vehicle's fuel efficiency.

Fuel Consumption as a Function of Distance



In order to double the fuel displacement obtained with a 4kWh battery, the battery size had to be quadrupled to 16kWh.

Drive Cycle Description and Analysis

Real-world drive cycles were measured by the U.S. Environmental Protection Agency in a 2005 study in Kansas City, Missouri, with more than 100 different drivers participating. PHEVs produced in 2001 and later were instrumented and their driving statistics were collected for a day. Vehicle speed was collected independently from the conventional vehicles on a second-by-second basis through an onboard diagnostic port and a global positioning system device.

Key Findings

Since drive cycles had different characteristics based on distances driven, the benefits of each vehicle configuration were dependent on how far the vehicle was driven. While electrical consumption was similar for short and long driving distances because they depended more heavily on the electrical power, the main differences occurred during medium distance trips. With medium trips it was more difficult to measure the benefits since there were low and high electrical energy driving demands.

Based on these characteristics and cost assumptions, the cost of PHEVs remains high. For the average driver, results of a cost-benefit analysis showed that assuming an electrical cost of $0.09/kWh and a fuel cost of $4/gallon, it would take 8 to 12.5 years to recover the additional cost of the PHEV and 7.5 years of driving an HEV to recover that vehicle's additional cost, compared to a conventional vehicle. More research and development are needed to improve the cost efficiencies of batteries and fuel.

A portion of this broad study was presented at the 2009 Advanced Automotive Battery Conference (AABC) in Long Beach, California, on June 11, 2009.

This research was supported by the Department of Energy's Vehicle Technologies Program under the direction of Lee Slezak and Phil Patterson.

For more information, contact
Aymeric Rousseau
630.252.7261
arousseau@anl.gov

Eco-Engineers from The Ohio State University Win Gold at 2009 EcoCAR Competition

On June 12, 2009, students from The Ohio State University (OSU) earned top honors at the 2009 finals of the EcoCAR: The NeXt Challenge competition in Toronto, Ontario, Canada, for their design of an Extended-Range Electric Vehicle (EREV).

OSU took first place out of 17 universities in the U.S. and Canada that competed in the first major milestone of this three-year competition, which is sponsored by the U.S. Department of Energy, General Motors, and many others including the Government of Canada. The competition challenges university engineering students across North America to re-engineer a 2009 Saturn Vue to improve fuel efficiency and reduce emissions while retaining the vehicle's performance and consumer appeal.

For this first year of competition, students were tasked with creating innovative concepts for their vehicle design and given the opportunity to use advanced software and computer modeling tools which allowed for testing and refinement under the simulation of real-world conditions.

The winning team's EREV provides a practical solution that will increase energy efficiency and reduce environmental impacts. OSU's design was powered by a 1.8 liter engine and fueled by E85 ethanol. The next-generation design predicts a 300 percent increase in fuel economy over the production 4-cylinder vehicle.

"My teammates and I are thrilled to be named this year's winner of the EcoCAR competition," said Eric Schacht, a student engineer and team leader from the OSU team. "The many long days and late nights spent perfecting our vehicle design paid off today, and we couldn't be more grateful for the opportunity to participate in such an important competition."

The second place vehicle design, engineered by students at the University of Victoria, is also an EREV that runs on E85 ethanol. Mississippi State University was awarded third place for its B20 biodiesel EREV.

For more information, contact
Kristen de la Rosa
512.323.0587
kdelarosa@anl.gov

EcoCAR Web site: www.ecocarchallenge.org

Mark Maher (left), Executive Director, GM Global Powertrain Engineering, congratulates The Ohio State University on their first place win in the 2009 EcoCAR Competition Finals along with John Lushetsky, Acting Deputy Assistant Secretary of the U.S. Department of Energy and Lisa Raitt, Minister of Natural Resources, Canada (both far right). The six-day competition was held in Toronto, Ontario, Canada, and concluded on Friday, June 12, 2009.

Energy Frontier Research Centers Promise Advances in Transportation Technologies

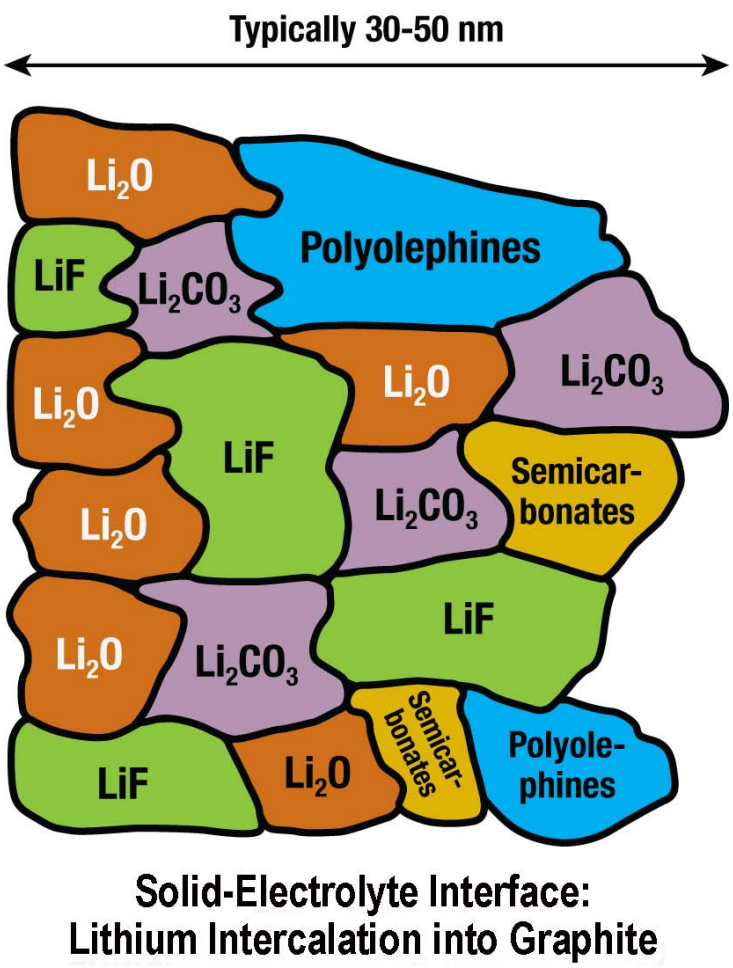
The U.S. Department of Energy's (DOE's) Office of Science recently awarded Argonne two Energy Frontier Research Centers (EFRCs). With these awards comes the possibility for important discoveries in advanced transportation technology. The Centers, each funded at $19 million over five years, will work with partnering universities to advance basic science in electrochemical energy storage and in catalysis. DOE established the EFRCs as a means to enlist the talents and skills of the very best American scientists and engineers to address current fundamental scientific roadblocks to U.S. energy security.

Center for Electrical Energy Storage

The Center for Electrical Energy Storage (CEES) will explore the challenges that have limited the advancement and use of electrochemical energy storage (EES) technologies, including batteries and supercapacitors for transportation, residential, and commercial use. Although EES devices have been available for many decades, there are fundamental gaps in understanding the atomic- and molecular-level processes that govern their operation, performance limitations and failure. With a full understanding of these processes, new concepts can be formulated for addressing present EES technology gaps and meeting future energy storage requirements.

Under the leadership of Argonne's Michael Thackeray, the CEES brings together 17 scientists from Argonne, the University of Illinois at Urbana-Champaign and Northwestern University. "CEES' main goal," Thackeray said, "is to gain a fundamental understanding of the interfacial phenomena that control electrochemical processes in electrical energy storage devices. This understanding will lay the foundation for the synthesis and design of electrode and electrolyte architectures that will lead to the discovery of future generations of energy storage materials and enable the development of batteries with enhanced capacity, power, safety and longevity."

The Center's emphasis is on lithium batteries since they provide the best opportunity for greater-than-incremental advances.



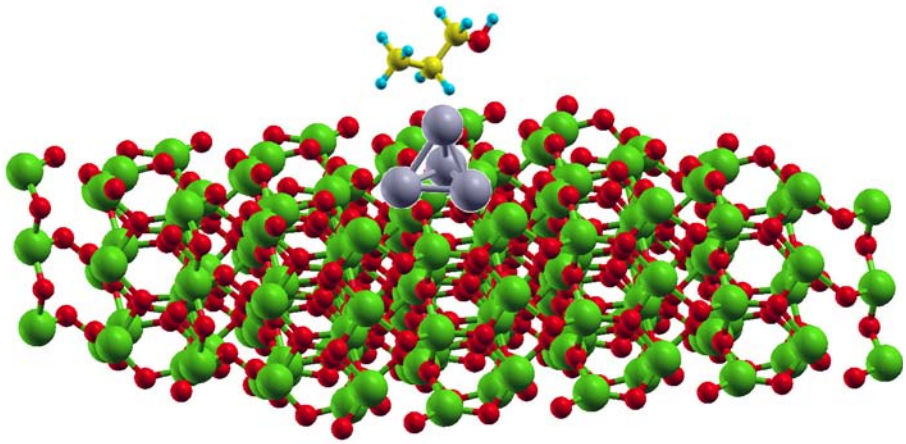
The solid-electrolyte interface is a critical component in electrochemical energy storage. Because of the high reactivity between the electrolyte and the electrodes at the SEI interface, Li-ion batteries show limited calendar and cycle life--less than two years, which is much lower than the 15 years required for enabling this technology in vehicles.

Institute for Atom-Efficient Chemical Transformations

The Institute for Atom-Efficient Chemical Transformations (IACT) will address key catalytic conversions that could improve the efficiency of fuel production from coal and biomass, the two main chemical energy resources in the United States.

The U.S. could grow and convert enough biomass to replace nearly a third of the nation's current gasoline use. However, a technology for economically converting biomass into widely usable fuels does not exist; the fundamental science needed to develop such a technology is still in its infancy. The challenge is to understand the chemistry involved in converting cellulose- and lignin-derived molecules to fuels and to use that knowledge to identify the needed catalysts.

Conceptual Four-atom Cluster of Platinum on Alumina



The platinum particle is interacting with a molecule of propanol. The propanol is a gas phase surrogate for the heavier cellulose materials that are the focus of one of Argonne's Energy Frontier Research Centers, the Institute for Atom-Efficient Chemical Transformations.

To obtain energy densities similar to those of currently used fuels, the products of biomass conversion must have oxygen contents lower than that of biomass. Oxygen must be removed by using hydrogen to minimize the yield of carbon dioxide as a byproduct. This important chemistry is a unifying theme of IACT's research.

"Catalysts found in nature demonstrate how amazingly efficient and selective catalysts can be," said Argonne chemist Christopher Marshall, principal investigator and IACT director. "The Institute's aim is to achieve the type of control and efficiency of chemical conversions that are found in nature."

New catalytic materials will be needed and a major emphasis of IACT is to synthesize new, complex, multisite and multifunctional catalytic materials that offer new models for catalysis. Using advanced computation and modeling to interpret, understand and optimize experimental results is also a critical part of advancing catalytic science. Advanced characterization techniques and catalytic experimentation will be employed, as well.

Argonne's partners in IACT are Northwestern University, Purdue University and the University of Wisconsin-Madison. IACT Director Marshall will be assisted by Deputy Director Peter Stair, who has a joint appointment with Northwestern University and Argonne.

Scientists for CEES and IACT will use the research facilities of each partnering organization, including Argonne's Advanced Photon Source, Center for Nanoscale Materials and the Argonne Leadership Computing Facility. The CEES also will use the resources of Argonne's Applied Battery Research and Development Program.

To read more about Argonne's EFRC awards, please visit www.anl.gov/Media_Center/News/2009/news090428.html.

For more information on CEES, contact
Michael Thackeray
630.252.9184
thackeray@anl.gov

For more information on IACT, contact
Christopher Marshall
630.252.4310
marshall@anl.gov

EFRC Web site: www.er.doe.gov/bes/efrc.html
CEES Web site: www.anl.gov/energy-storage-science
IACT Web site: www.anl.gov/catalysis-science

Air Force Fellows Help Work Toward Smarter Diesel Engines

One of the three core values of the U.S. Air Force is "excellence in all we do." So it should be no surprise that two Air Force officers recently teamed up with Argonne researchers to study ways to improve the efficiency of military vehicles

Lieutenant Colonel Jeff Gillen and Major Clint Abell were the fourth set of Air Force Fellows to spend time at Argonne, but the first to be stationed in Argonne's Center for Transportation Research (CTR).

"Our primary mission is to understand the capabilities of Argonne National Laboratory and link them up with Air Force research needs," Gillen said.

Each year, the Air Force selects a handful of officers to serve in its National Technical Laboratory Fellowship program which places them at national laboratories across the country for one-year fellowships. Gillen and Abell began their fellowships in July 2008.

The officers were involved in a variety of work at the laboratory, but they also were required to select and participate in the day-to-day operations of one specific research project.

"Since energy is such a national concern right now and the Air Force is the largest energy user in the U.S., we thought it would be a good idea to work on an energy-related project," Gillen said.

For their research work, Gillen and Abell chose to work with Steve McConnell and other Argonne engineers to improve the efficiency of diesel engines. The project used ion sensors to help the engine calibrate itself to burn available fuels as efficiently as possible.

The work is similar to Argonne's omnivorous engine project, which also uses ionization sensing to optimize combustion. However, McConnell pointed out that working with the diesel engine is a little more complex than the spark-ignited engine being used in the omnivorous project.

McConnell was surprised by how much the officers were able to contribute in such a short amount of time.

"I was expecting more of a learning curve," McConnell said. "Without these guys here, I don't think we'd have gotten as far along as we did."

Lieutenant Colonel Jeff Gillen and Argonne engineer Steve McConnell take a close look at the Smarter Diesel Engine (SDE) 21.

The Argonne project is particularly relevant for the Air Force because of its single-fuel concept. This means that it's not only the aircrafts that run on jet fuel; it's the ground support vehicles as well.

The single-fuel concept helps simplify logistics and fuel operations, but it also means that support vehicles, like Humvees, do not run at maximum efficiency.

"The Air Force is interested in Argonne's innovative technological advancements that support our global position as a leaner, more efficient, high-performance, world-class fighting force," said Abell. "Having a smarter diesel engine would support that goal."

The Argonne project involved looking at four different types of jet fuels provided by the Air Force. McConnell said their research has also drawn outside interest from Army TACOM (U.S. Army Tank-automotive and Armaments Command) and Sasol, a South African company involved in mining, energy, chemicals and synfuels.

Though their fellowship ended this summer, the officers believe their time at Argonne will have a lasting impact.

"We were here to assist with the research, but also to foster a long-term relationship with Argonne," Gillen said. "We plan to stay in contact, facilitate working together and hopefully contribute to smarter, better technologies for the Air Force."

After Argonne, Abell headed to the F.E. Warren Air Force Base in Wyoming to be a flight commander, while Gillen is now stationed at the Pentagon where he works directly with the Assistant Secretary of the Air Force Installations, Environment and Logistics.

Major Clint Abell (center), Steve McConnell, Lt. Col. Jeff Gillen, Thomas Wallner and Steve Ciatti (in back, left to right) have been working together on a project to create a smarter diesel engine.

Major Clint Abell holds an ion sensor that will allow a diesel engine to calibrate itself to burn available fuels as efficiently as possible.

Harold Myron, director of educational programs at Argonne, said the fellowship has been a great success, not just for the participants, but for the country.

"Mutual respect and understanding of capabilities has been apparent from the beginning," Myron said. "Now we understand each other better."

For more information, contact
Steve McConnell
630.252.3080
smcconnell@anl.gov

Argonne's Division of Educational Programs Web site: www.dep.anl.gov

Interns Play an Important Role in Argonne's Transportation Research

Advanced engine testing and tribology research aren't part of typical summer internships. But here at Argonne those are a few of the responsibilities taken on by interns in the Lab's Transportation Technology Research and Development Center (TTRDC).

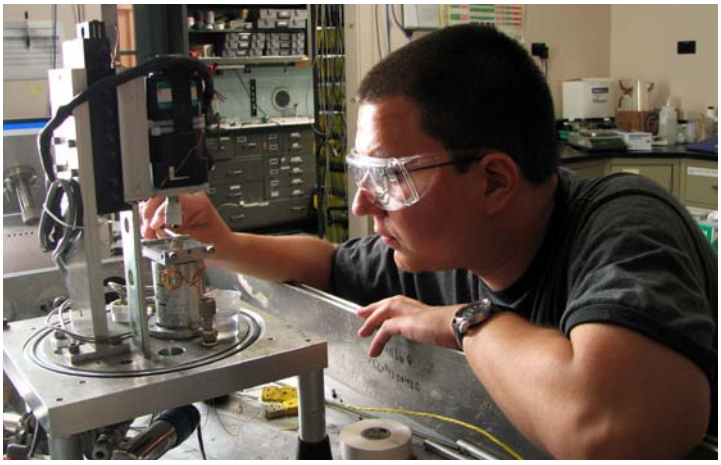
As a whole, the Lab had 250 students from all levels of education participate in the summer internship program. Here, Argonne interns gather to hear a speaker at one of their weekly seminars.

This summer, 25 students from colleges and universities across the country worked with TTRDC researchers on a wide variety of projects. These internships gave students the unique opportunity to gain hands-on experience working on groundbreaking studies in cutting-edge laboratory environments. Most interns were hired for 10 weeks, and wrapped up their time on July 31.

"It just sounds good saying I worked at Argonne," said Ryan Vojtech, an engineering student at Southern Illinois University. "Having an internship at a recognized facility like this is pretty substantial."

Vojtech worked with Argonne engineer Steve Ciatti to run experiments on different biodiesel fuel blends for General Motors.

The lab's summer internship programs have a great impact on the recruitment of students to careers in research. Participants in Argonne's programs are twice as likely to secure research and development positions and three times as likely to work in a federal laboratory compared to those who do not participate.



Zachary Tennessen, Southern Illinois University, installs a test specimen into the hydrogen tribometer test machine.

Ellen Briggs, a student who graduated from College of DuPage in Glen Ellyn this spring, participated in the Department of Energy's Community College Institute. For her 10-week internship, she worked with visiting scholar Christine Matta on tribology research projects. (Tribology is the science and technology of friction, wear and lubrication of surfaces in relative motion.)

Ellen Briggs, College of DuPage, installs a specimen into a tribological test machine that is being used to measure the friction and wear properties of novel engine lubricating additives.

"I studied chemistry and hadn't heard of tribology until I came here," Briggs said. "I plan to make a career in research at a government lab—hopefully Argonne—or in academia."

Cory Adams, a Penn State University student, also saw this opportunity as a great stepping stone. He plans to go on to graduate school and then pursue a career in transportation research.

"Whenever I talked to my professors, they always asked how my internship was going," Adams said. "It was a great experience. I think it will definitely help me get my foot in the door."

But the students aren't the only ones who benefit from these internships. Argonne scientists and engineers also get some much needed help with their research.

Adams worked with engineer Thomas Wallner to run engine tests in Argonne's Advanced Powertrain Research Facility.

Aleksander Navratil, Carroll College, performs viscosity measurements on engine oil formulations for a program researching oils and additives to improve engine efficiency and reduce emissions.

"It was a great help having him around," Wallner said. "We gave him a lot of responsibility, and he showed that he could handle it. He wanted to do engine testing and he got a lot of it."

Argonne metallurgist Bob Erck had interns doing everything from upgrading laboratory computer systems and improving the design of test instruments to analyzing numerical data and characterizing results using optical and other microscopy.

"The interns provided valuable assistance in the research work of the tribology section," Erck said. "They performed a great deal of day-to-day work that would otherwise need to be performed by the staff members."

Lauren Valentor, a senior at the University of Wisconsin-Madison, was one of the interns working in tribology. Valentor's work focused on nanocomposite layers on diamond-like carbon coatings. "The only downside to my internship at Argonne is that it only lasted 10 weeks," she said.

Argonne's Division of Educational Programs is the largest in the Department of Energy system and sponsors traditional internships, teacher training and other programs that take advantage of the laboratory's unique facilities.

For more information, contact
Harold Myron
630.252.4114
hmyron@dep.anl.gov

Argonne's Division of Educational Programs
Web site:
www.dep.anl.gov/p_undergrad/summer.htm

Facility Spotlight: Fourier Transform Infrared Spectrometer

FTIR: A nimble tool repurposed

Chemists have traditionally used the Fourier Transform Infrared (FTIR) Spectrometer System on the chemical benchtop to measure hydrocarbons, ammonia and nitrogen oxides. Argonne's creative transportation engineers have now found a new use for this instrument in the Laboratory's Advanced Powertrain Research Facility to measure vehicle exhaust emissions as well.

"This tool is needed to test new fuels, to determine if a new fuel is practical and not toxic," said Henry Ng, mechanical engineer and chief fuels researcher. "This is an optical measurement instrument that can analyze up to 25 different exhaust components simultaneously, including measuring nitrogen oxide (NO_x) in the presence of ammonia."

FTIR connected to VW Jetta testing vehicle in Argonne's Advanced Powertrain Research Facility

Since plug-in hybrid electric vehicle emissions are lower than emissions from gasoline powered vehicles, a specialized tool that can measure the smaller amounts is needed. "The main advantage is that the FTIR can measure raw, undiluted exhaust at a much lower, granular level," said Ng. "More groups of chemicals are collected with the raw exhaust, since they haven't been diluted out. These include greenhouse gases—especially nitrous oxide—as well as hydrocarbons, nitrogen oxides, aldehydes and ammonia."

The FTIR can provide detailed real-time measurements for up to 25 different exhaust components at the same time.

The portable FTIR is on casters and can be moved to various test cells as needed. It has also been used to measure the engine exhaust emissions of butanol and ethanol. In addition, two other Argonne test facilities are using the FTIR: the Engine Research Facility has used it to measure emissions from natural gas combustion, and the Locomotive Engine Research Facility successfully used it to measure NO_x in the presence of ammonia.

For more information, contact
Henry Ng
630.252.3992
hng@anl.gov

In the News

March 2009 – How will electric vehicles stay charged? **Ted Bohn** is quoted in "Plug into Opportunity," online at *Electrical Contractor*. www.ecmag.com/index.cfm?fa=article&articleID=9965

March 2009 – A new incarnation of lithium-ion batteries based on solid polymers is in the works. **Khalil Amine** is quoted in *Technology Review's* "Better Lithium-Ion Batteries." www.technologyreview.com/energy/22351/

March 2009 – Argonne Director **Eric Isaacs** answers transportation-related questions in an interview on *Chicago Tonight*. www.wttw.com/main.taf?p=42,8,8&vid=033109d

Argonne Director Eric Isaacs answers transportation questions during a Chicago Tonight interview.

May 2009 – **Michael Wang** is quoted in the article, "Burning Biomass to Charge Electric Vehicles Beats Fueling Cars with Ethanol," online at *IEEE Spectrum*. www.spectrum.ieee.org/green-tech/advanced-cars/burning-biomass-to-charge-electric-vehicles-beats-fueling-cars-with-ethanol

May 2009 – **Linda Gaines** and **Terry Levinson** are quoted in the article, "Putting U.S. Trucking on a Diet," in *The New York Times* special report. www.nytimes.com/2009/05/19/business/global/19rentruck.html?_r=4&ref=global

May 2009 – Argonne and Hanyang U. in South Korea have developed a new high-energy cathode material as described in ECN *Asia Magazine's* piece, "High-Energy Cathode Material Can Significantly Increase Safety, Life of Lithium Batteries." **Khalil Amine** is quoted. www.ecnasiamag.com/article-25637-highenergycathodematerialcansignificantlyincreasesafety-lifeoflithiumbatteries-Asia.html

June 2009 – Argonne Director **Eric Isaacs** talks about "How Electric Car Superbatteries Surge Ahead," in *Business Week*. www.businessweek.com/managing/economic_recovery/blog/archives/2009/06/new_electric_ca.html#more

June 2009 – **Jeff Chamberlain** talks lithium-ion batteries on *The Bob and Sheri Show*. bobandsheri.1079thelink.com/archive/audio.cfm?ID=1322&postalcode=60515

June 2009 – **Michael Wang** answers the question, "How Green is Your Gasoline," on *Fox News*. www.foxnews.com/story/0,2933,527066,00.html

June 2009 – EnerDel was awarded $3.3 Million to collaborate with Argonne on safety research on automotive lithium-ion batteries. **Khalil Amine** comments about the project on *PR Newswire*. news.prnewswire.com/DisplayReleaseContent.aspx?ACCT=104&STORY=/www/story/06-22-2009/0005047675&EDATE=

August 2009 – **Linda Gaines** is quoted in *Technology Review's* "Lithium Battery Recycling Gets a Boost." www.technologyreview.com/energy/23215/

August 2009 – **Don Hillebrand** discusses the Chevy Volt in "GM Says New Car is Capable of 230 MPG" in *The Washington Post*. www.washingtonpost.com/wp-dyn/content/article/2009/08/11/AR2009081101090.html

August 2009 – **Michael Duoba** is interviewed for the *Reuters'* article, "Electric Car Sticker Shock Awaits U.S. Consumers." www.reuters.com/article/latestCrisis/idUSN16336272

August 2009 – **Ted Bohn** talks ultracapacitors in the article, "Ultracaps Could Boost Hybrid Efficiency" in *Technology Review*. www.technologyreview.com/energy/23289/

August 2009 – Battery research by **Khalil Amine** and **Zonghai Chen** is highlighted in "Chemistry Change in Batteries Could Make for Safer Electric Cars" in *The New York Times*. www.nytimes.com/gwire/2009/08/24/24greenwire-chemistry-change-in-batteries-could-make-for-s-34626.html

FASTRAX

Marcy Rood Werpy, along with **Renée Nault**, coordinated the 15th anniversary of the U.S. Department of Energy's Clean Cities Program in Washington, D.C., on March 3, 2009.

Forrest Jehlik

Forrest Jehlik was a guest lecturer at the University of Wisconsin-Madison's Lindbergh Lecture series on March 12, 2009, presenting an overview of Argonne's Advanced Powertrain Research Facility, research specific to plug-in hybrid efficiency as a function of thermal state, an overview of the nation's petroleum dependency, and the importance of research and science for securing a sustainable energy future.

Khalil Amine, **Ilias Belharouak** and **Zonghai Chen** won an Excellence in Technology Transfer Award from the Federal Laboratory Consortium for Technology Transfer. The award was in recognition of their work on a battery system expected to help reduce greenhouse gas emissions and America's dependence on imported oil and was presented on April 7, 2009. See article on page 3.

Marianne Mintz, **Dan Santini** and **Marcy Rood Werpy** participated in conference panels at the 2009 Alternative Fuels and Vehicles National Conference and Expo in Orlando, Florida, April 19-22, 2009.

Thomas Wallner presented recent results of hydrogen combustion engine research at the SAE World Congress in Detroit, Michigan, April 2009. The work, co-authored by Abhijeet Nande and Jeff Naber (both of Michigan Technological University), is titled "Of Basic Injection Configurations Using a Direct-Injection Hydrogen Research Engine."

U.S. Transportation Secretary Ray LaHood and U.S. Representative Judy Biggert (R-IL-13th) toured Argonne's Transportation Technology Research and Development Center on April 24, 2009. Lab Director **Eric Isaacs** led the tour, which included stops at Argonne's Advanced Powertrain Research Facility and Locomotive Engine Research Facility. **Larry Johnson** presented an overview of the transportation research at Argonne.

Transportation Secretary Ray LaHood and U.S. Representative Judy Biggert review a plug-in hybrid electric vehicle (PHEV) test platform at Argonne National Laboratory. From left to right: Argonne Energy Systems Deputy Division Director, Donald Hillebrand; Secretary of U.S. Department of Transportation, Ray LaHood; U.S. Representative, Illinois-District 13, Judy Biggert; Argonne National Laboratory Director, Eric Isaacs.

Forrest Jehlik presented the work, "Methodology and Analysis of Determining Plug-In Hybrid Engine Thermal State and Resulting Efficiency," at the 2009 SAE World Congress, April 2009.

Dominik Karbowski, **Felix Freiherr von Pechmann**, **Sylvain Pagerit**, **Jason Kwon** and **Aymeric Rousseau** presented their work, "Fair Comparison of Powertrain Configurations for Plug-In Hybrid Operation using Global Optimization" (SAE paper 2009-01-1383), at the SAE World Congress, Detroit, Michigan, April 2009.

Thomas Wallner, research engineer in Argonne's Center for Transportation Research, has been appointed adjunct professor in the Mechanical Engineering/Engineering Mechanics Department at Michigan Technological University.

Chris Cooney, a Ph.D. student at Michigan Technological University doing his thesis research at Argonne, presented the study, "Effects of Blending Gasoline with Ethanol and Butanol on Engine Efficiency and Emissions," at the 2009 ASME Spring Technical Conference in Milwaukee, Wisconsin, May 3-6, 2009. The paper was co-authored by **Thomas Wallner** and **Steve McConnell** (both Argonne), Jeff Gillen and Clint Abell (U.S. Air Force), and Scott Miers and Jeff Naber (Michigan Technological University).

Romesh Kumar received a 2009 DOE Hydrogen Program Award on May 26, 2009. The award recognizes Kumar's "outstanding leadership and contributions in determining the cost and performance impacts of hydrogen impurities."

Romesh Kumar receives DOE Hydrogen Program R&D Award. From left to right: Antonio Ruiz, DOE Vehicle Technologies; Romesh Kumar; Fred Joseck, Systems Analysis Team Lead in the DOE Hydrogen Program; and Sunita Satyapal, Manager, DOE Hydrogen Program.

Khalil Amine presented the talk, "Toward Enabling PHEV Batteries Using Advanced New Electrode Materials," at the Advanced Automotive Batteries and Capacitors (AABC) conference in Long Beach, California, on June 8, 2009.

Thomas Wallner presented the results of an injection study performed on Argonne's hydrogen research engine at the 2009 SAE International Powertrains, Fuels and Lubricants Congress in Florence, Italy, June 15-17, 2009. The study, "Assessment of Multiple Injection Strategies in a Direct Injection Hydrogren Research Engine," was co-authored by **Riccardo Scarcelli** (Argonne), and Abhijeet Nande and Jeff Naber (both Michigan Technological University).

Aymeric Rousseau, **Ayman Moawad**, **Gurhari Singh**, **Simeon Hagspiel** and **Mohammed Fellah** presented their study, "Impact of Real-World Drive Cycles on PHEV Fuel Efficiency and Cost for Different Powertrain and Battery Characteristics," at the Advanced Automotive Batteries and Capacitors (AABC) conference in Long Beach, California, June 2009.

Argonne's Battery Technology Group was recently awarded the following contracts: an 18-month project funded through EnerDel by the Defense Logistic Agency to develop the high-energy cathode and anode for a high-energy UAV (unmanned arial vehicle) and a contract with Nissan/EnerDel to jointly develop an advanced nonflammable electrolyte for electric vehicle applications based on Argonne's silane technology. In addition, DOE awarded Argonne/EnerDel funds to develop and quantify a new redox shuttle to prevent battery overcharge.

Ted Bohn

Ted Bohn attended the 4th Annual Hybridfest Green Drive Expo in Madison, Wisconsin on July 17-19, 2009, and made a presentation on applications of smart charging of PHEVs relative to the capabilities of the smart grid.

Neeraj Shidore, **Jason Kwon** and **Anant Vyas** presented the work, "Trade-off Between PHEV Fuel-Efficiency and Estimated Battery Cycle Life with Cost Analysis," at the 5th IEEE Vehicle Power and Propulsion Conference (VPPC '09), September 7-11, 2009, in Dearborn, Michigan.

Ali Erdemir and **Osman Levent Eryilmaz** received a 2009 R&D 100 award for the development of a superhard and slick coating that helps increase engine efficiency and component reliability.

Argonne's **Michael Thackeray**, **Khalil Amine**, **Christopher Johnson**, **Sun-Ho Kang**, **Ilias Belharouak** and **Haixa Deng** were honored with a 2009 R&D 100 award for their work in developing the Argonne/Envia composite electrode material technology for hybrid and all-electric vehicles.

Larry Johnson gave a series of invited lectures in China in September. These included the 2009 International Forum on China Automotive Industry Development in Tianjin, Tongji University in Shanghai and Tsinghua University in Beijing.

PUTTING ARGONNE'S RESOURCES TO WORK FOR YOU

Industrial technology development is an important way for the national laboratories to transfer the benefits of publicly funded research to industry to help strengthen the nation's technology base. The stories highlighted in this issue of TransForum represent some of the ways Argonne works with the transportation industry to improve processes, create products and markets, and lead the way to cost-effective transportation solutions, which in turn lead to a healthier economic future.

By working with Argonne through various types of cost-sharing arrangements, companies can jump-start their efforts to develop the next generation of transportation technologies without shouldering the often prohibitive cost of initial R&D alone. Argonne has participated in dozens of these partnerships and has even been involved in helping to launch start-up companies based on the products and technologies developed here.

If working with world-class scientists and engineers, having access to state-of-the-art user facilities and resources, and leveraging your company's own capabilities sound like good business opportunities to you, please contact our Office of Technology Transfer and see how we can put our resources to work for you.

Stephen Ban, Director
Office of Technology Transfer
630.252.8111
sdban@anl.gov

or

Office of Technology Transfer
Argonne National Laboratory, Bldg. 201
9700 South Cass Avenue, Argonne, IL 60439
800.627.2596
partners@anl.gov
www.anl.gov/techtransfer
www.transportation.anl.gov (under "Working with Argonne")

TransForum ▸▸ Volume 9, No. 2, Fall 2009

Contributors: Jim Collins, Angela Hardin, Kathy Obmascik, Aymeric Rousseau, Else Tennessen, Patricia Weikersheimer, Suzanne Williams and Shari Zussman.

TransForum is published by the Transportation Technology R&D Center, Argonne National Laboratory. Publishing support services are provided by Argonne's Technical Services Division. Art direction/design by Cindi Andersen.

Information in TransForum may be reproduced for publication with acknowledgment to TransForum, Argonne National Laboratory. Address correspondence, subscription requests, and address changes to:

Renée M. Nault
TransForum
Argonne National Laboratory
9700 South Cass Avenue, Bldg. 362
Argonne, IL 60439-4815
630.252.6064
rmnault@anl.gov

This publication was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor UChicago Argonne, LLC, nor any of their employees or officers, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of document authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof, Argonne National Laboratory, or UChicago Argonne, LLC.

Printed on recycled paper.

Argonne NATIONAL LABORATORY
9700 South Cass Avenue
Argonne, IL 60439

Non-Profit Organization
U.S. Postage Paid
Lemont, IL
Permit No. 87