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TransForum

News From Argonne's Transportation Technology R&D Center

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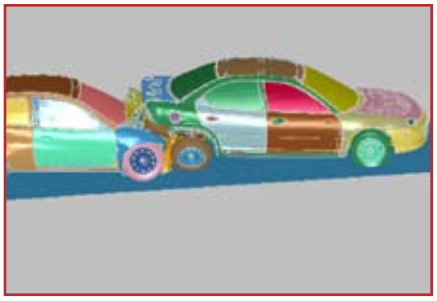
▸▸ RESEARCH REVIEWS



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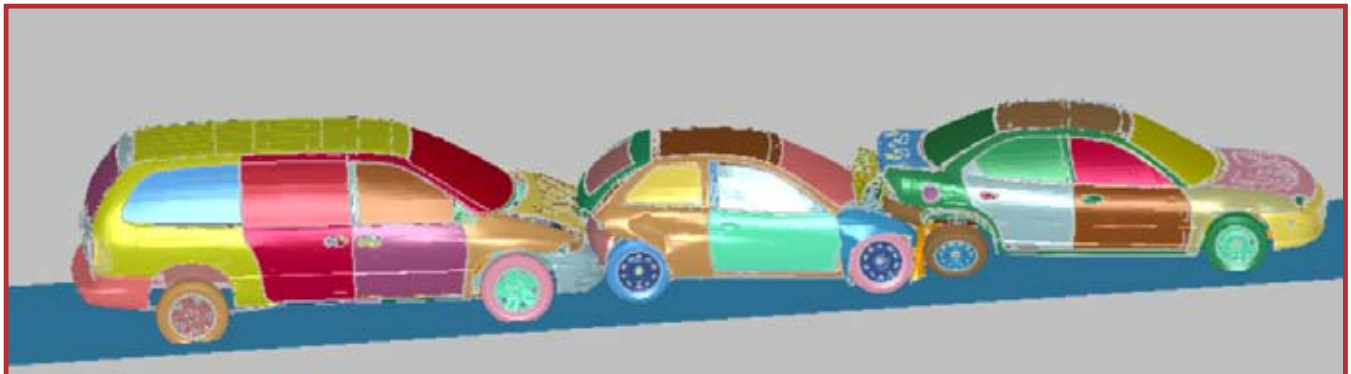
TRACC Opens Its Doors for Business

Argonne National Laboratory, in cooperation with the U.S. Department of Transportation's Research and Innovative Technology Administration, has announced the opening of the Transportation Research and Analysis Computing Center (TRACC).

This new, state-of-the-art modeling, simulation and high performance computing center has opened its doors at the DuPage National Technology Park, co-located with the DuPage Airport Authority in West Chicago, Illinois. TRACC provides advanced computing capability and high-tech models of a number of different transportation-related systems, vehicles and components. A new high-performance computing system, installed at the TRACC site, delivers substantial power to compute exceedingly large and detailed simulations.

With respect to their use in traffic modeling, Weber expects that TRACC simulations will closely resemble actual road conditions, allowing transportation system planners and emergency planning specialists to develop alternative and contingency plans in advance. "If you lose part of your transportation network in an emergency, for example, what do you do? How do you get the people out in the most efficient way?" Weber said. "We think we'll be able to predict congestion patterns as they actually occur for both normal traffic and emergency traffic conditions." Although TRACC models currently encompass only the Chicago area, they could easily be adapted for any metropolitan region.

The models that TRACC will generate have the potential to save lives on both the individual and community scales by



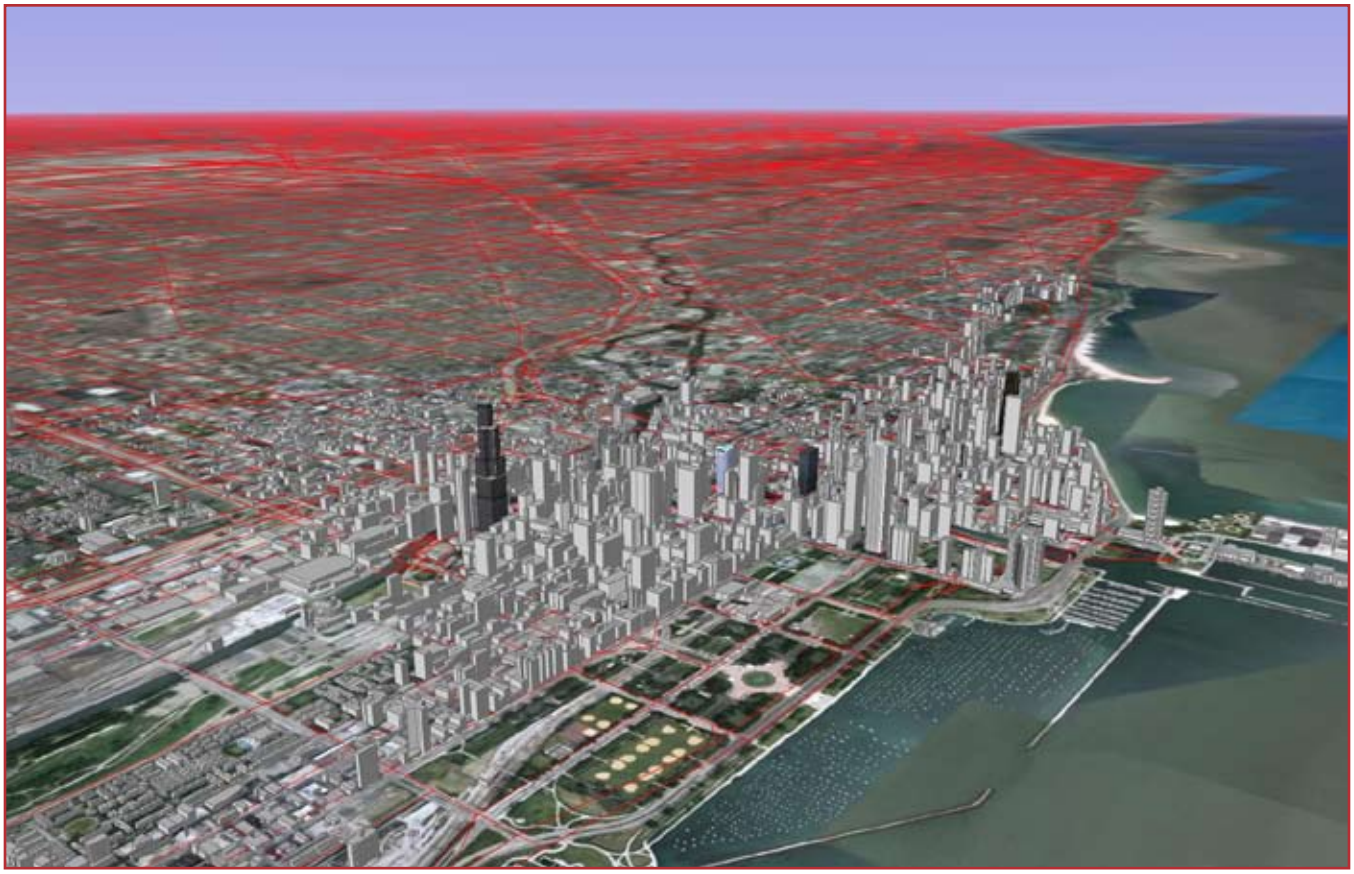
High-fidelity finite-element modeling of complex crash scenarios, such as multiple vehicle crashes, are required to develop mechanisms that can increase passenger safety within vehicles and reduce pedestrian injury. Using TRACC's high-performance cluster computer, researchers can perform similar simulations using much less computing time.

With this computing power, TRACC can deliver second-by-second simulations of traffic in an entire metropolitan region, model the response of bridges under stress (such as high wind or flood conditions), evaluate vehicle crashworthiness through computational crash test simulations and examine the reliability and optimize the design of roadside safety structures.

The center concentrates its computing power and modeling expertise in a number of different areas related to transportation systems and vehicle performance, including a wide variety of applications from aerodynamic drag on vehicles to injector spray dynamics, to road weather research, to underhood thermal management. "These areas that we're starting with are just a few specific examples of how you could use the high-performance computer," said Dr. David Weber, TRACC Project Director. "Our modeling, simulation, visualization and high-performance computing capabilities will provide unique collaboration opportunities with colleagues in the transportation field from government, academia and private industry. We all benefit from this advanced modeling capability," he said.

better understanding crash behaviors and using that knowledge to enhance roadside safety structures. For example, while the U.S. Department of Transportation and the vehicle industry currently perform computerized crash simulations in addition to their expensive real-world crash tests, TRACC technology can significantly increase the speed and accuracy with which these tests can be executed. "We take prototypic experiments and confirm that we can model them accurately, to validate the simulation methodology. Then we can use the computer models to extend them to a larger range of accident conditions, and examine system and component performance at higher levels of fidelity with our large-scale computing resources," Weber said.

TRACC also has initial funding to perform modeling of bridge hydraulic behavior, such as the flooding of bridges during severe weather events. By seeing how bridges respond to stress from high winds and rising water, civil engineers might be able to prevent damage to bridges during severe storms or hurricanes.



TRACC, Northern Illinois University, and the Chicago Metropolitan Agency for Planning are updating the road network in the Chicago Business District based on aerial photography and other public or commercial resources to provide the high-fidelity input required by the microsimulation code TRANSIMS. TRANSIMS is being used for traffic modeling, including such applications as traffic simulation in metropolitan areas, evacuation planning and evaluation, and long-range regional planning.

"Tests are very expensive and can only look at a limited number of conditions," Weber said. "TRACC provides a more cost-efficient way to look at a lot of different types of transportation issues and understand the effects in greater detail." At the heart of TRACC lies a 128-node, 512-core massively parallel computer. This high-performance computing system is complemented by state-of-the-art software and expert staff.

The computing system will be available using the high-speed networks available at the DuPage National Technology Park, thus providing access for technical collaborators to the computing and visualization facilities both at TRACC and at Argonne's university partners at the University of Illinois and Northern Illinois University.

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Argonne Tests Validate BMW Hydrogen 7 Emissions Well Below SULEV

Independent tests conducted by engineers at the U.S. Department of Energy's Argonne National Laboratory on a BMW Hydrogen 7 prototype vehicle have validated the luxury automaker's own tests, which found that the car's hydrogen-powered engine surpasses the super-ultra low-emission vehicle (SULEV) level, the most stringent emissions performance standard to date.

"The BMW Hydrogen 7's emissions were only a fraction of SULEV level, making it one of the lowest emitting combustion engine vehicles that have been manufactured," said Thomas Wallner, a mechanical engineer who leads Argonne's hydrogen vehicle testing activities. "Moreover, the car's engine actively cleans the air. Argonne's testing shows that the Hydrogen 7's 12-cylinder engine actually shows emissions levels that, for certain constituents, are cleaner than the ambient air the car's engine took in."

It was not an easy task to measure the Hydrogen 7's emissions. "A gross polluter is easy to measure, but the cleaner the car the harder it is to test," said Don Hillebrand, director of Argonne's Center for Transportation Research. "Most labs test at the SULEV level. Argonne's vehicle testing facilities are unique in that they are able to detect even the most nuanced level of emissions. In this case, it was near-zero emissions."

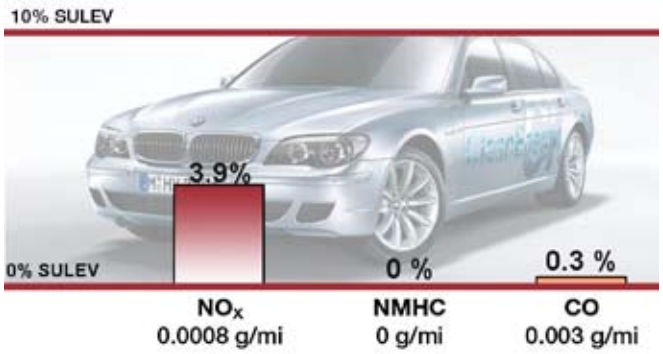
After an extensive evaluation by BMW, "Argonne's Advanced Powertrain Research Facility was found to be the only public test facility in North America capable of testing hydrogen vehicles at these low emissions levels," said BMW's Wolfgang Thiel, Manager of Operating Support Emissions Analysis. "Zero is a very small precise number—we are pushing the boundaries of emissions testing."

Technical information about the Hydrogen 7 tests was presented by Wallner and BMW North America's Jason P. Perron on Wednesday, April 2, during the National Hydrogen Association Annual Hydrogen Conference in Sacramento, California. Argonne joined BMW in a press conference to present the test results during the Society of Automotive Engineers 2008 World Congress in Detroit, Michigan, also in April.

BMW has put the hydrogen model into limited series production. Although the vehicle is not yet available for sale to the general public, it is being made available to "influential public figures," whose use will demonstrate a new era in clean energy, BMW has said. In the meantime, the greatest challenge to widespread use of hydrogen cars is the limited number of hydrogen refueling stations.

The BMW Hydrogen 7 Mono-Fuel demonstration vehicle is parked for the mandatory soak period prior to emissions testing at Argonne National Laboratory's Advanced Powertrain Research Facility.

As testing gets underway in Argonne's Advanced Powertrain Research Facility dynamometer test cell, Peter Lutter of the BMW Group (left) and Steve Gurski, a research and test engineer at Argonne, oversee initial results.



The BMW Hydrogen 7's emissions were only a fraction of SULEV level, making it one of the lowest emitting combustion engine vehicles that have been manufactured.

Specialized equipment at the APRF includes a full-dilution emissions sampling system with a water as well as a hydrogen analyzer. The test cell is equipped with an integrated hydrogen warning and ventilation system.

Geoff Amann, a senior technician at Argonne (in car), and the BMW Group's Peter Lutter discuss final preparations for emissions testing of the BMW Hydrogen 7 Mono-Fuel demonstration vehicle.

Argonne mechanical engineer Thomas Wallner (right) and Wolfgang Thiel of the BMW Group review data from emissions tests conducted on the BMW Hydrogen 7 Mono-Fuel demonstration vehicle. Wallner leads Argonne's hydrogen vehicle testing activities. Test results showed that the car's hydrogen-powered engine surpasses the (SULEV) level, the most stringent emissions performance standard to date.

BMW found Argonne's Advanced Powertrain Research Facility to be the only public test facility in North America capable of testing hydrogen vehicles at these low emissions levels.

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Argonne and Toda Kogyo Partner on Lithium-Ion Battery Technology License

In a huge leap forward to bring consumers longer-lasting, safer lithium-ion batteries, Argonne and Toda Kogyo of Japan recently signed a world-wide licensing agreement to commercially produce and sell Argonne's patented composite cathode materials.

"Our agreement with Toda Kogyo is an important step toward bringing to market key advanced lithium-ion battery technologies that are being developed here at Argonne with funding from the U.S. Department of Energy (DOE)," said Gary Henriksen, Manager of the Electrochemical Energy Storage Department at Argonne. "The technologies being licensed will enhance the performance, life and inherent safety of lithium-ion cells compared to those that employ the cobalt-based cathode technology that has dominated the market since the introduction of lithium-ion batteries in 1990." Toda Kogyo can make materials for more than 30 million laptop batteries per year.

Lithium-ion batteries made with Argonne's materials can store up to 30 percent more energy than lithium ion cells now on the market. These batteries are also less combustible. Both these advantages will be a boon to the hybrid-electric vehicle, laptop, and electronics markets.

Front, left to right: Argonne National Laboratory Director Robert Rosner, Toda's Kenji Ogisu. Back, left to right: Argonne Inventors Sun-Ho Kang, Chris Johnson, Mike Thackeray, Khalil Amine.

The new cathode materials form a composite matrix of a stable, inactive lithium-metal oxide integrated with a highly active form of another lithium-metal oxide component. This composite allows for greater amounts of lithium to be used and reduces oxygen-induced side reactions that may lead to combustion, limiting cell life and safety. The enhanced stability of these materials allows a battery to be charged to higher voltages, which means increased energy storage. The battery can also be charged many more times, which means longer shelf life.

"We are very enthusiastic about the impact of Toda's commitment to manufacture and market these technologies through the license," Steve Ban, director of Argonne's Office of Technology Transfer, said. "We believe the near-term commercial use of these materials and other battery technologies developed at Argonne will provide broad benefits to users of batteries containing the advanced materials and prove the value of closely linking research in basic battery science to applied R&D efforts in the area, as is the approach here at Argonne."

A next step in research will be to improve the charge and discharge rate of the materials so they can be used in batteries for plug-in hybrid electric vehicles.

Toda Kogyo Corporation is a respected supplier of materials in the lithium-ion and nickel-metal hydride battery markets. The company recently acquired a plant in the Detroit area that will help serve U.S. automobile manufacturers. Toda's plant in Ontario, Canada, produces cathode materials and their precursors for lithium-ion and nickel-metal hydride batteries.

This cathode technology is just one of many lithium-ion battery inventions and patents developed at Argonne and funded primarily by the DOE's Vehicle Technologies Program. DOE's commercialization efforts aim at rapidly moving a new technology, product or process from concept to market.

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Introducing *EcoCAR: The NeXt Challenge,* North America's Premier Collegiate Automotive Engineering Competition

Kicking off in the 2008-2009 academic year, *EcoCAR* is the latest in a 19-year series of Advanced Vehicle Technology Competitions sponsored by the U.S. Department of Energy (DOE), an automotive manufacturer and managed by Argonne National Laboratory. The goals of the competitions are to stimulate the development and demonstration of advanced propulsion and alternative fuel technologies and to train the next generation of engineers to lead the industry in the 21st Century.

EcoCAR is a three-year competition that will challenge students to re-engineer a vehicle donated by General Motors (GM), using advanced vehicle technologies to reduce the vehicle's total environmental impact and lead the way to a sustainable transportation future.

Students from sixteen university teams will follow the General Motors Global Vehicle Development process to design, simulate and build their advanced technology vehicles. Students will gain hands-on experience in a real-world vehicle development process and will build leadership and teamwork skills, not only in engineering, but also in business development, fundraising, journalism and public relations.

Selected *EcoCAR* teams will design and build fully functional electric, hybrid, plug-in hybrid or fuel cell hybrid vehicles based on similar categories from the California Zero Emission Vehicle regulations. The student teams will integrate advanced-technology powertrains, lightweight materials, aerodynamic improvements, and will use various alternative fuels such as ethanol, biodiesel and hydrogen into their vehicles.

At the end of the three-year competition each team is expected to have developed a fully-functional, production prototype vehicle that has higher fuel economy and lower greenhouse gas and criteria emissions while still retaining the utility and customer acceptability of the stock vehicle.

Sixteen competing teams from North America will be selected from the 300 accredited engineering schools who received DOE's *EcoCAR* Request for Proposal released on December 3, 2007. The winners will be announced on May 21, 2008, at the *EcoCAR* Kickoff at DOE headquarters in Washington, D.C. The date coincides with the finish line ceremony and finale of *ChallengeX*, DOE's current collegiate vehicle competition (see www.challengex.org).

The selection of schools for the *EcoCAR* Challenge is based on several factors including the quality of their proposal, available facilities, school and financial support, technical expertise and experience, and geographic diversity. Teams will receive

Argonne's Mike Wahlstrom and DOE's Steven Boyd perform a safety inspection on U. Tennessee's vehicle at the Challenge X Winter Workshop in Los Angeles.

seed money, a wide range of powertrain components, a vehicle donated by GM, and technical and mentoring support from the competition sponsors. In turn, schools must provide matching funds, class credit, faculty advising, and logistical and promotional support for their teams.

In Year One, teams will focus on vehicle design using Argonne's Powertrain System Analysis Toolkit, sophisticated software-in-the-loop and hardware-in-the-loop simulation techniques, and rapid control system prototyping.

In Years Two and Three, in a vehicle donated by GM, students will install powertrain components and controllers developed in Year One. Students will build the vehicle they modeled in Year One and continue to refine their simulation, testing and hardware control efforts while improving vehicle efficiency and functionality.

At the end of each of the three *EcoCAR* years, there will be a weeklong competition at a GM vehicle proving ground or other appropriate location in North America.

EcoCAR Challenge is funded by the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Vehicle Technologies Program.

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Argonne and Partners Develop Advanced Nanolubrication Systems using MoS_2

Ali Erdemir, Argonne senior scientist, has spent nearly two decades looking for ways to reduce friction between sliding surfaces. During that time, Erdemir and his colleagues have produced two remarkable inventions: near-frictionless carbon coatings and motor oil additives based on extremely small nanoparticles of boric acid. The latter innovation gave Erdemir the inspiration to look into other nano particulate materials, such as molybdenum disulfide (MoS_2), a molecule with a structure very similar to that of boric acid.

In 2007, the U.S. Department of Energy (DOE) awarded funding for MoS_2 research. The federal funds are supporting research into the use of very small particles of MoS_2 as a lubricant additive for motor oils. Scientists from the University of Arkansas, Caterpillar and nanoMech LLC are working together with Argonne to develop and test this new additive.

To the naked eye, MoS_2 is a greasy black solid that looks and feels very much like graphite. The root of its slick texture, however, lies in its molecular structure, in which molybdenum atoms form sheets sandwiched by layers of sulfur atoms. The weak bonding between the planes of sulfur atoms allows them to slide over one another easily, resulting in extremely low coefficients of friction.

A MoS_2 additive might prove especially valuable for the types of industrial and agricultural equipment that represent many of Caterpillar's products, Erdemir said. "Dust can make its way into the crank case and cause abrasive wear, so with this kind of additive the severity of that wear will be reduced," he said. The additive may also result in increased fuel economy and reduced emissions in vehicles.

Experiments on the additive are now underway at Argonne and preliminary results show that MoS_2 is indeed a promising new low-friction additive. These preliminary results will be presented at the annual meeting of the Society of Tribologists and Lubrication Engineers in May 2008. Erdemir and his collaborators are hopeful that presenting these positive initial findings will lead to more industry interest resulting in new funding opportunities and collaboration. In addition, a scientific journal article about the MoS_2 additive preliminary findings is in the draft stage.

Ali Erdemir uses a ring-on-liner test machine to test the performance of lubricants as a function of temperature.

The MoS_2 additive project appealed to DOE because it represents an ideal collaboration scenario, with a university, a laboratory and two industrial companies all working together to develop a product that meets a real-world need. Professor Ajay Malshe and others at the University of Arkansas engineered the particle size, which they then licensed to nanoMech LLC for manufacturing and distribution. Argonne's role in the project involves testing the performance of the MoS_2 additive. The University of Arkansas approached Argonne because of the Laboratory's positive reputation in the area of nanolubrication.

This two-year project began in late 2007. Year One work involves bench-top experimentation and optimization of the nanoparticle composition. Year two work will involve component testing and performance validation by Caterpillar.

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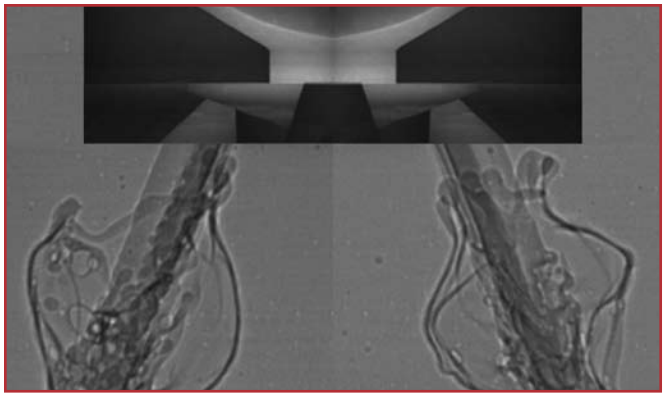
New X-ray Technique May Lead to Better,Cleaner Fuel Injectors for Automobiles

Standard microscopy and visible light imaging techniques cannot peer into the dark centers of dense-liquid jets, which keep scientists from fully understanding liquid breakup in devices such as automobile fuel injectors.

Argonne physicist Kamel Fezzaa and his colleagues, along with collaborators from Visteon Corp., developed a new, ultrafast technique to look through high-speed dense liquids using high-energy X-rays from Argonne's Advanced Photon Source (APS).

"Research in this area has been a predicament for some time, and there has been a great need for accurate experimental measurement," Fezzaa said. "Now we can capture the internal structure of the jet and map its velocity with clarity and confidence, which wasn't possible before."

A key to the experiment was taking advantage of the special properties of the X-ray beam generated at the APS. Unlike hospital X-rays, APS X-rays are a trillion times brighter and come in very short pulses with durations as little as 0.1 nanoseconds.

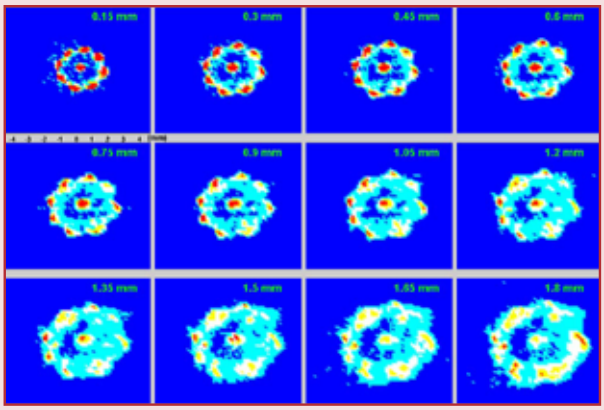


The liquid breakup of a high-density stream from a fuel injector as imaged with ultrafast synchrotron x-ray full-field phase contrast imaging at Argonne's X-ray Operations and Research beamline 32-ID. The internal structure of the nozzle is visible, as well as the liquid jets emanating from the two orifices.

The new technique has the ability to examine the internal structure of materials at high speed, and is sensitive to boundaries. Multiphase flows, such as high-speed jets or bubbles in a stream of water, are ideal systems to study with this technique. Other applications include the dynamics of material failure under explosive or ballistic impact, which is of major importance to transportation safety and national security, and material diffusion under intense heat.

This work is highlighted in the Advance Online Publication of the journal *Nature Physics* (see http://www.nature.com/nphys/journal/vaop/ncurrent/index.html).

Earlier Fuel Spray Research



In earlier efforts, a number of "first ever" results occurred when Argonne researchers at the Advanced Photon Source, working with Visteon Corp. and Cornell University, used ultrafast monochromatic X-tomography to study the near-field, multi-orifice gasoline direct injection sprays. The effort yielded, for the first time ever, a highly quantitative characterization of the dynamic mass distribution in the spray with very precise time resolution.

Also, calculations proved that sprays from modern direct injectors are atomized only a few millimeters from the nozzle. As shown here, the breakup immediately at the nozzle exit is verified by the detailed 3-dimensional reconstruction of a fuel spray. However, a more thorough understanding of the fuel breakup and spray formation process required higher temporal and spatial resolutions in the X-ray images. This work is described in the accompanying article.

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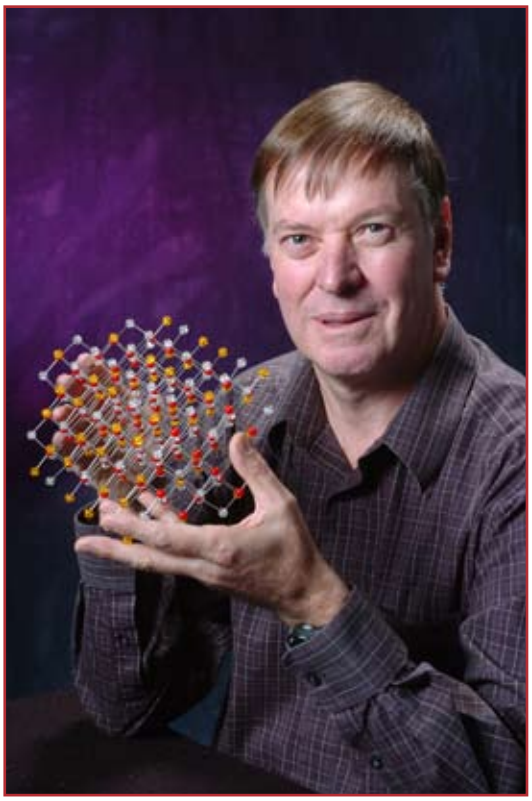
Argonne's Lithium-Ion Battery Technology Offers Reliability, Greater Safety

Argonne's an internationally recognized leader in the development of lithium-battery technology."Our success reflects a combined effort with a materials group and a technology group to exploit the concept to tackle key safety and energy problems associated with conventional technology," said Argonne's Michael Thackeray.

Recently, Argonne announced a licensing agreement with NanoeXa (see TransForum 7:2), a partnership that will introduce lithium-ion batteries with increased power output, storage capacity, safety, and lifetime. This partnership comes at a key time in the evolution of lithium-battery technology, especially as automakers eye these batteries as power sources for high-tech automotive applications. Successful application and public acceptance of the technology, however, depends on reliability, performance, and safety—the highest priority.

"What we're trying to do is to make the materials [used in lithium-ion batteries] safer for transportation applications," explained Thackeray. In fact, the safety issues associated with lithium-ion batteries grow as the cell size increases beyond what is currently used for consumer electronics—especially to the sizes needed for electric vehicle and hybrid electric vehicle applications.



Researcher Michael Thackeray holds a model of the molecular structure associated with Argonne's advanced cathode material, a key element of the material licensed to NanoeXa.

Argonne's an internationally recognized leader in the development of lithium-battery technology.

To improve safety, Thackeray's colleagues in Argonne's Battery Technology Department are studying the thermal properties of lithium-ion cells and the mechanisms that control thermal runaway in conventional lithium-ion cell chemistries. Thermal runaway is a safety issue widely acknowledged and reported. To illustrate, in summer 2006, the media reported lithium-ion battery fires that were caused, at least in part, by thermal events. The result was massive battery recalls, forcing battery manufacturers to face significant financial losses.

Argonne has addressed that problem successfully by developing structurally integrated composite cathodes for lithium-ion batteries. "We have found," said Thackeray, "that our composite cathodes are less likely to cause thermal runaway compared to conventional layered lithium-metal-oxide electrodes such as $LiCoO_2$." Thackeray and his colleagues have developed stabilized lithium-manganese-nickel-oxide cathode materials that can tolerate high charging potentials. This approach cuts material costs by nearly half, extends life, and—importantly—improves safety.

"Our strategy is to use integrated materials to make electrode structures safer. In addition, we're improving safety by preconditioning the electrodes prior to use," explained Thackeray. "Also, colleagues of mine in our department have been successful in developing new electrolyte additives, which form more stable passivation films on the electrodes, thereby extending battery life and enhancing inherent safety."

In its continuing R&D efforts, Argonne is tailoring the composition of these structurally integrated "layered-layered" electrodes to achieve very high capacities. Argonne's strategy has proven highly successful. Said Thackeray, "We have demonstrated that our composite electrode structures have significant advantages over conventional lithium-ion battery electrodes in terms of their structural, electrochemical, and thermal properties."

These advantages translate into benefits to the lithium-ion battery industry and, ultimately, consumers who use products powered by these batteries. With further development, Argonne's battery technology can be used in applications in which rechargeable batteries with high energy and high power are needed while maintaining a high standard for safety. Ultimately, they could be used in transportation applications, where the need for power, long life, and reliability are essential.

As the science advances, the need to attract industry interest becomes more important. Increased visibility helps ensure that successful science done in the laboratory reaches those who can best put it to use. On February 23, 2007, Thackeray—by invitation from the White House—met with President Bush and

participated in a round-table discussion on the role of lithium-ion batteries for transportation, including plug-in hybrid electric vehicles. Through this discussion, Thackeray had the opportunity to provide an overview on advanced batteries, address the challenges of advanced battery research and development, and talk about the path forward to achieving commercially viable lithium-ion battery-powered vehicles.

The future for Argonne's technology is promising. "Our technology is precisely what is needed to enable a timely switch from a fossil-fuel economy to an economy that relies on alternative energy sources." Argonne's composite cathode invention offers the lithium-ion battery industry increased energy, power, and lifetime, with improved safety at a reduced cost. The attributes and advantages of Argonne's materials hold considerable promise for further improvements in the next generation of lithium-ion batteries.

This work is was funded by the Department of Energy, Office of Energy Efficient and Renewable Energy, Vehicle Technologies Program.

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FASTRAX

The paper, "Spray density measurements using X-ray radiography," authored by **Alan Kastengren** and **Christopher Powell**, discusses Argonne's work using x-rays to study fuel injection and atomization. It was featured in a special issue of *The Journal of Automobile Engineering.*

The paper, "Establishing combustion temperature in a hydrogen-fueled engine using spectroscopic measurements" authored by **Steve Ciatti, Thomas Wallner** and **Bipin Bihari**, presents a novel method for measuring in-cylinder gas temperature in hydrogen combustion. It was featured in a special issue of *The Journal of Automobile Engineering.*

Michael Wang was among 5 employees given a 2007 Distinguished Performance Award by the UChicago Argonne, LLC Board of Governors. The award recognizes outstanding scientific or technical achievements, or a distinguished record of achievement. Wang's GREET (Greenhouse gases, Regulated Emissions, and Energy use in Transportation) software model has become the "gold standard" for well-to-wheel analysis of vehicle and fuel systems. More than 5,600 GREET users in both the public and private sectors are registered throughout North America, Europe, and Asia.

Don Hillebrand testified about Plug-in Hybrid Electric Vehicle batteries before the House Appropriations Subcommittee on Energy and Water Development during February 2008. View more on the web at http://www.anl.gov/Media_Center/News/2008/news080214.html.

Richard Doctor and **Michael Wang** were panelists at a round-table titled "The CO2 Challenge: Capture and Storage" held at the Michelin Challenge Bibendum in Shanghai, China during November of 2007. View more on the web at http://www.challengebibendum.com/challengeBib/AfficheServlet?Rubrique=20070904190201&Langue=EN.

Renée M. Nault won an award of Excellence in Technical Publications from the Society for Technical Communication for her promotional piece titled, "Hydrogen and Fuel Cells: Power for the 21st Century."

In a national competition, **Suzanne D. Williams**, **Renée M. Nault** and **Sana Ann Sandler** received a Distinguished Award in Technical Publications from the Society for Technical Communication (STC) for their "Plug-In Hybrid Electric Vehicle Promotions Materials." In STC's international competition, these publications also received a Merit Award.

Don Hillebrand was featured on *Forbes.com* in its "Green Car: 10 People to Watch" online story and in *Newsweek.com*'s online story, "Miles to Go: Why Automakers Don't Sell a Car That Gets 50mpg."

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.

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