Energy & Environmental Sciences
Quarterly

Published by Oak Ridge National Laboratory

No. 8 2013

DOE grant to support enhanced biofuel crop design

DOE has awarded a $14.3 million grant to study crassulacean acid metabolism (CAM) and drought tolerance in biofuel crops to a research team that includes ORNL and the University of Tennessee.

"CAM is a photosynthetic CO_2 fixation mechanism common in plants that grow in hot and arid environments to maximize water use efficiency," said team member Xiaohan Yang, of ORNL's Biosciences Division. The project will attempt to engineer a CAM pathway in poplar and *Arabidopsis* (a model plant for studying plant biology), Yang said. Introducing the CAM machinery into a bioenergy crop like poplar would enable it to use water more efficiently and thrive on marginal land.

Funding for the five year project is from the Genomic Science program in DOE's Office of Biological and Environmental Research. Other ORNL researchers participating in the project include BSD's Anne Borland, Jin-Gui Chen, Guruprasad Kora, Madhavi Martin, Timothy Tschaplinski, Gerald Tuskan, and David Weston. The Universities of Nevada and Liverpool and Newcastle University are also part of the research team.

Biosciences Division's Xiaohan Yang works with a model plant for CAM genomics research.

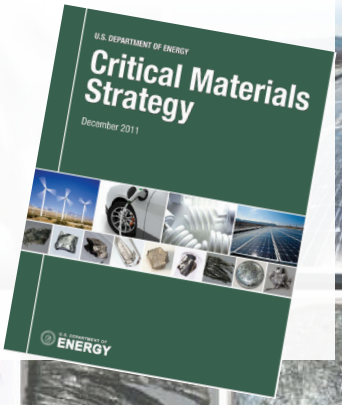
ORNL partners on critical materials hub

ORNL wins big as part of a team led by Ames Laboratory, which was selected for an Energy Innovation Hub to address shortages of critical materials, including rare earth metals. The award of up to $120 million over five years for the Critical Materials Institute involves four national labs, academia, and industrial partners.

ORNL will play a key role in conducting the CMI's mission to eliminate materials criticality as an impediment to the commercialization of clean energy technologies. Working with other CMI partners, ORNL will lead efforts for diversifying supply of critical materials with emphasis on developing more efficient separation processes for improving material yield as well as developing processes for other sources of rare earths. In addition, the lab will serve as deputy lead of substitutions for critical materials to replace the rare earths in such applications as permanent magnetics and lighting. Activities will also encompass additive manufacturing in order to reduce the amount of rare earth materials for permanent magnetics and utilizing magnetic field processing to determine the effects of magnetic fields on the growth of rare earth containing magnetic alloys.

Other national labs partnering with Ames and ORNL include Idaho National Laboratory and Lawrence Livermore National Laboratory. University and research partners include Brown University, the Colorado School of Mines, Purdue University, Rutgers University, University of California-Davis, Iowa State University, and Florida Industrial and Phosphate Research Institute. Industry partners that have joined to help advance CMI-developed technologies include General Electric, OLI Systems Inc., SpinTek Filtration Inc., Advanced Recovery, Cytec Inc., Molycorp Inc., and Simbol Materials.

The Critical Materials Institute builds on the Department of Energy's Critical Materials Strategy report, which addresses the use of rare earths and other critical materials in clean energy components, products, and processes.



In the Spotlight

Harnessing the diverse capabilities of ORNL staff and facilities to drive a sustainability agenda is high on new director Jay Gulledge's list of plans for the 140-employee Environmental Sciences Division.

Jay, who replaced retiring ESD director Gary Jacobs in early January, is enthusiastic about the possibilities afforded by the Lab's multidisciplinary expertise, including its "unparalleled" computing capabilities. He cites the Lab's three-year-old Climate Change Science Institute, staffed by scientists with diverse skills across many disciplines, as a great model. "Everything that is needed already exists here," Jay said. "Pulling it all together to work toward common goals is the next step."

The next few generations will be impacted by climate change in areas such as the economy and quality of life at a level unlike anything seen in the last 100 years, Jay said. He cited the effects of rapid urban growth in the early 1900s, when factory-generated air pollution choked city dwellers, who also suffered from diseases caused by poor waste disposal practices. "I really want to inform society in how it makes decisions about sustainability," Jay said. "Not just write scientific papers, but effect change on how society interacts with the environment. That's what a national lab should be doing."

In addition to climate change and environmental sustainability efforts, ESD has a broad portfolio of bioenergy supply studies, ecological sciences, environmental monitoring, and contamination remediation research. The division plays a key role in the relationship between ORNL and the Climate and Environmental Sciences Division of the Office of Biological and Environmental Research in DOE's Office of Science.

Jay most recently was with the Center for Climate and Energy Solutions in Arlington, VA. He holds a Ph.D. in ecosystems sciences from the University of Alaska–Fairbanks, and a B.S. and M.S. in microbiology from the University of Texas–Arlington. He was a Life Sciences Research Foundation Postdoctoral Fellow in molecular microbial ecology at Harvard University and later held faculty positions at Tulane University and University of Louisville.

Jay Gulledge

Billion-Ton API released during Energy Datapalooza

To allow better access to data from the US Billion-Ton Update, a study of the potential of domestically produced biofuels, a team lead by ORNL researchers has developed an application programming interface. The Billion-Ton API allows developers and researchers to more easily integrate Billion-Ton data into their models and applications without having to host the information on their own systems.

The API was released on October 1 at the White House Energy Datapalooza, where more than 150 US entrepreneurs, software developers, energy experts, and policy makers gathered to celebrate new products, services, and apps advancing a secure, clean energy future—all built with freely available data from the government and other sources.

ORNL team members include Computational Sciences and Engineering Division's Aaron Myers, Sunil Movva, Budhendra Bhaduri, Rajasekar Karthik, and Phil Nugent, and Environmental Sciences Division's Laurence Eaton. The team's efforts support the Bioenergy Knowledge Discovery Framework project funded by DOE's Office of Biomass Programs.

Decision-making models for reproducing intelligence in transportation

It could be the start of a good riddle: How many synapses of the brain does it take to figure out how to improve fuel efficiency? If you're Andreas Malikopoulos, Energy and Transportation Science Division researcher and Alvin M. Weinberg Fellow, the answer is far from simple.

In late 2010, Andreas joined ETSD with an interest in developing the information and decision science (IDS) thrust area and a desire to uncover how the brain works through reverse engineering. According to Andreas, reverse engineering the brain can reveal its secret code and functions – keys to developing decision-making models that enable the creation of thinking machines capable of emulating human intelligence. The intention is to weave ideas from statistical signal processing, stochastic control, and information theory into new ones drawn from neuroscience, statistical learning theory, and game theory in order to create models that can represent four key functions of the brain--perception, attention, learning, and intelligence.

"Outcomes from understanding more about the brain could greatly impact and yield great increases in fuel and energy efficiency. We could also apply this knowledge in a number of other areas such as manufacturing, safety, healthcare and even finance," Andreas said.

His research to date has largely focused on issues related to vehicle fuel efficiency. Andreas can implement computational intelligence models—based on data gleaned from reverse engineering of certain brain functionality—that can predict future behavior based on the user's driving habits and patterns and adjust accordingly.

"This allows the vehicle to learn the driver, just like the brain allows us to learn based on past experience. As the vehicle gets smarter, its performance becomes more efficient to, for example, optimize miles per gallon," he explained.

A more recent IDS research effort is a project called iVEHICLE (intelligent VEhicle and HIghway Communication Leverage for Efficiency) that involves an optimization framework and control algorithms that will allow vehicles to "talk" to each other and with advanced information systems, sharing information so conventional vehicles will learn how to optimize fuel efficiency and plug-in HEVs will learn how to optimize their overall range.

Prior to joining ORNL, Andreas worked for General Motors Global Research & Development conducting research in the area of stochastic control and hybrid systems with an emphasis on applications to advanced propulsion systems. As he seeks new findings at the intersection of neuroscience and engineering, he is connecting with DOE and industry representatives who are looking into opportunities to further explore the potential benefits of this research.

For more information of Andreas' research, see the following articles that were published in *Green Car Congress* in recent months:
http://www.greencarcongress.com/2013/01/aam-20130104.html
http://www.greencarcongress.com/2012/10/malikopoulos-20121003.html
http://www.greencarcongress.com/2012/05/malikopoulos-20120524.html

ORNL develops low-cost, self-cleaning coatings for solar reflectors

A team led by Scott Hunter in the Measurement Science and Systems Engineering Division has begun a two year project to develop durable, self-cleaning, optically transparent coatings for heliostats and collector mirrors at concentrating solar power facilities.

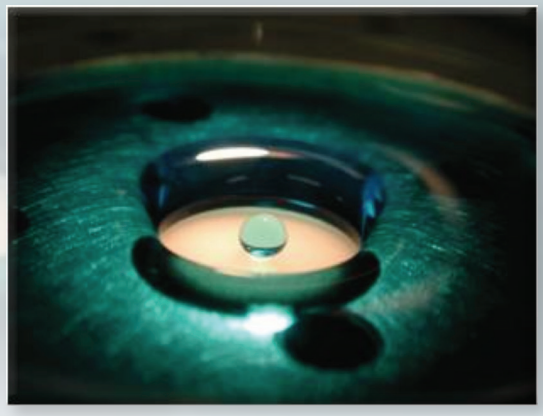
The research, sponsored by the Concentrating Solar Power Program of DOE's Sunspot Initiative, is based on ORNL's superhydrophobic technology.

CSP plants, typically located in deserts, use hundreds of thousands of large mirrors to reflect solar energy onto receivers for energy conversion. Routine cleaning via jet spraying and manual scrubbing, involving up to a million gallons of deionized water, is required to remove dirt and dust and maintain reflectivity. The cleaning poses challenges including high labor and water costs, competition with local communities for water, and environmental impacts of the runoff.

In superhydrophobic coating, a nanostructure is applied to a hydrophobic surface, making it essentially impervious to wetting by water. ORNL researchers have determined superhydrophobic surfaces are also resistant to aqueous solutions and viscous liquids, such as mud, and many solid particles. ORNL's unique coatings consist of particles suspended in polymeric binders and do not use conventional vacuum deposition or chemical etching techniques. This makes them potentially inexpensive and easily applicable on most surfaces using conventional spraying or painting methods.

ORNL has demonstrated that transparent, self-cleaning coatings can be applied to small laboratory samples. In the first year, the project aims to develop self-cleaning coatings that are durable while optimizing optical transparency. Field testing of coating performance will be performed in the second year.

Multifunctional superhydrophobic coatings also impart resistance to corrosion, icing, and biofouling. They are promising for numerous energy-related applications, including overhead power cables, infrastructure, solar panels, airfoils, coastal and offshore power and structural equipment, and ship hulls.

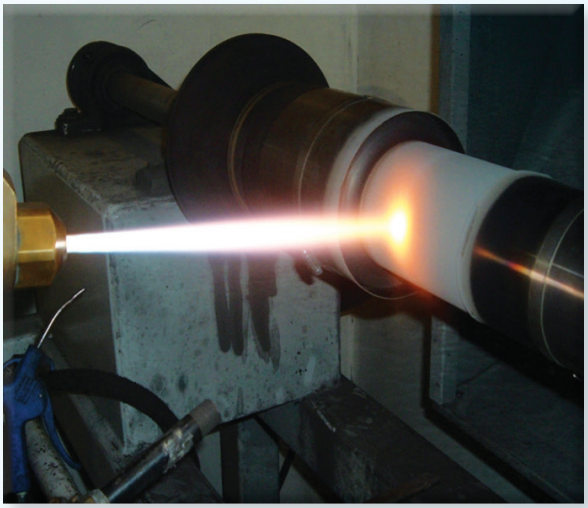


Superhydrophobic surface surrounded by a layer of water on an untreated surface.

ORNL technology takes Wall Street Journal Technology Innovation Award

CermaClad metal-coating process, which uses high-intensity light to fuse anti-corrosion materials to metal pipes, took the top spot in the 2012 Wall Street Journal Technology Innovation Awards. MesoCoat, a unit of Miami-based Abakan, licensed the technology from ORNL.

Commercial-scale production is expected to begin in March. MesoCoat officials said the technology produces better coatings at production rates 40 times faster than typical metal-cladding techniques, at 20% lower cost. Cladding, bonding corrosion- or wear-resistant materials to metals, is considered the best protection for pipes used in environments such as oil and gas production and mining.



The CermaClad process will to be used to apply a protective coating on the inner surfaces of pipelines used in oil and gas transportation. Treated pipes last at least six times longer than pipes made using traditional methods.

Refrigerant testing heats up

It's always something. Chlorofluorocarbon refrigerants were phased out in the 1990s because they damage the ozone layer of the atmosphere and were replaced mainly by hydrofluorocarbons. HFCs are safe for the ozone layer, but they are now a source of concern because they are potent greenhouse gases.

Chemical companies are developing new types of refrigerants that are ozone-safe and have low global warming potential, said researcher Brian Fricke of ORNL's Energy and Transportation Science Division. The question is how they will affect the energy efficiency of the equipment in which they're used. Brian, Omar Abdelaziz, and Vishal Sharma, also of ETSD, are conducting research to provide answers.

They are testing the energy performance of several proprietary next-generation refrigerants in actual supermarket refrigeration equipment using an instrumented two-chamber research setup, one representing the indoors and one the outdoors. Two 12 foot food refrigerator cases and three 12 foot freezer cases are in the indoor chamber, and their condenser and compressor rack are in the outdoor one. Plastic tubs filled with water simulate the load in the cases, and thermocouples measure the air temperature and the temperature in the tubs. "We're measuring the effects on the various components that make up whole refrigeration systems," Brian said.

Several industry partners are participating in the test, including chemical companies that are developing the new refrigerants and the equipment manufacturers who produce supermarket food cases.

"We're evaluating these refrigerants in terms of energy performance in supermarket refrigeration systems and weighing that against the other environmental impacts," Brian explained. To assess energy efficiency, they measure refrigerant flow rates as well as temperatures and pressures throughout the system, including the food cases and the compressors and condenser.

"We're using refrigeration equipment commonly used today. An owner doesn't want to replace his equipment—he wants to drop in a new refrigerant into the equipment he has," he noted. The tests will provide data for the efficiency of the different refrigerants and show equipment owners how using a particular refrigerant might affect their energy bills.

"Supermarket refrigeration systems take a large refrigerant charge, 2000 to 3000 pounds, and there is a high potential for leakage, so the potential environmental impact of leaks is significant," Brian said. On the other hand, reducing the energy efficiency of the systems would cause them to use more power, which could lead to higher emissions of carbon dioxide, another greenhouse gas.

"Right now, there are no regulations in the US for the commonly used refrigerants with high global-warming potential," Brian said. "Equipment manufacturers, chemical companies, equipment users, and regulators are all pushing for more environmentally friendly compounds."

Brian Fricke stocking refrigerated display cases inside the indoor research chamber.

Region wins $2.4 million for Advanced Manufacturing and Prototyping Center

The Advanced Manufacturing and Prototyping Center of East Tennessee (AMP!) is one of a network of public-private partnerships to help revitalize US manufacturing and encourage companies to invest in the United States.

AMP! is led by Tech 20/20, a public-private economic development organization headquartered in Oak Ridge, in partnership with ORNL, Pellissippi State Community College, and the University of Tennessee Center for Industrial Services. It will serve a 20-county area in East Tennessee. Tom Rogers, ORNL director of Industrial Partnerships and Economic Development, said the initiative "provides an opportunity for ORNL to work with our regional partners to translate research into commercial applications that will create new jobs and strengthen manufacturing in the US."

Training in additive manufacturing is identified as a critical need for economic development. AMP! will help community colleges and universities in the region provide more comprehensive and up-to-date skills and experience in advanced manufacturing. It will make the region attractive to small manufacturers who can benefit from the program.

The $2.4 million AMP! grant is part of a $20 million multi-agency announcement to spur manufacturing growth in the United States. Ten such partnerships were selected through the Advanced Manufacturing Jobs and Innovation Accelerator Challenge, a competitive process announced in 2012 to support initiatives to strengthen advanced manufacturing at the local level.

XG Sciences, ORNL partner on titanium/graphene composite materials

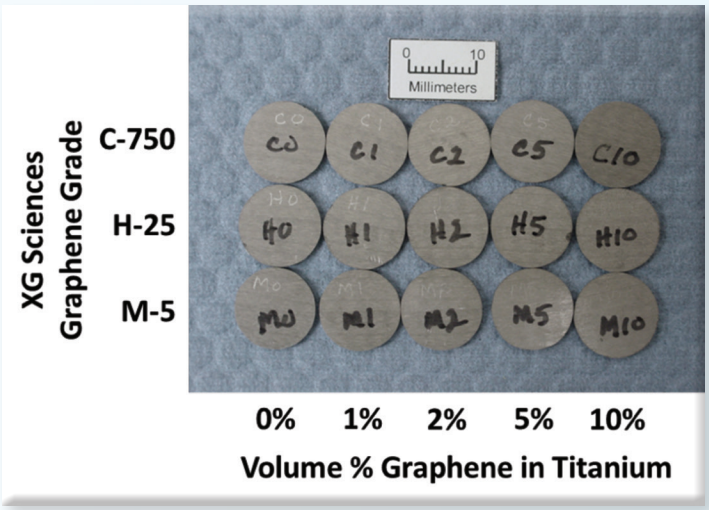
XG Sciences, a developer of graphene nanomaterials, and ORNL's Manufacturing Demonstration Facility are working together to develop a titanium/graphene composite that would have a greater range of applications than titanium alone. The effort uses advanced powder metallurgy manufacturing processes developed at ORNL.

Titanium is an important structural material for a variety of industrial, commercial, and military applications because of its light weight, high strength, and corrosion resistance. However, its use has been limited by its low thermal conductivity. Graphene-based materials, with excellent thermal conductivity, would be ideal reinforcements for improving both the thermal and the mechanical properties of titanium.

XG Sciences, headquartered in Lansing, Michigan, can mass-produce graphene nanoplatelets in high volume, and ORNL has capabilities for low-temperature powder metal processing. Together, the two organizations see opportunities to create advanced titanium/graphene composites.

"Graphene is an exciting new material with huge potential due to its fast electron mobility, high mechanical strength, and excellent thermal conductivity," said Liya Wang of XG Sciences. "Metal-matrix composites have not been explored in depth but offer a large potential market opportunity. We are glad to partner with Oak Ridge National Lab and use their Manufacturing Demonstration Facility to advance the graphene-based material technologies and help maintain the competitive advantages of the United States in developing and manufacturing high-tech products."

"ORNL is pleased to have the opportunity to work with XG Sciences to bring new materials technology closer to reality and introduction in the marketplace," said Stephen Nunn, Materials Science and Technology Division. "With a long history in materials development and the recently commissioned advanced processing capabilities at ORNL's Manufacturing Demonstration Facility, we are certain this will be a successful collaboration."



Titanium/graphene composite specimens prepared for flash thermal diffusivity measurement.

MAXLAB occupied, nearing fully equipped status

ORNL researchers have settled into new offices and laboratories at the MAXLAB—or Maximum Building Energy Efficiency Research Laboratory. Located on Bethel Valley Road, MAXLAB construction was completed at the end of September.

Sixteen staff members of the Building Technologies Research and Integration Center are based in the complex, including BTRIC director Patrick Hughes and members of the Building Envelope Research, Building Equipment Research, and Whole-Building and Community Integration groups.

MAXLAB is a DOE facility funded with $16 million of a $20.2 million competitive award from the American Recovery and Reinvestment Act. It will be used for research to advance the energy efficiency and durability of building envelopes (e.g., walls), equipment, and appliances. The 17,970 ft^2 building contains two research spaces: a high-bay area for building and characterizing large-scale wall assemblies and a low-bay area housing a heating, ventilation, and air-conditioning laboratory. Equipment installation began in early January. Both suites should be ready for use in April.

The high-bay area will house an apparatus for simultaneously testing air and moisture penetration of large-scale wall assemblies under any weather conditions encountered in the United States. Industry partners will participate in building wall assemblies that will be tested under controlled conditions to contribute to the building science behind future updates of building envelope codes and standards.

The HVAC environmental chambers in the low-bay area include an outdoor and four individually controlled indoor chambers. The chambers will initially support collaborative efforts with industry to develop various types of heat pumps, rooftop HVAC units, window air-conditioners, and laundry equipment coupled with heat pumps.

Outfitting of two-story FRP nears completion.

Companion facilities funded by the same ARRA project and called the light commercial building flexible research platforms (FRPs) are also near completion. Located across the street from MAXLAB, the single-story and two-story FRPs are being outfitted with their first test buildings. Prototype building energy efficiency technologies developed by ORNL and its industry partners will be tested there before being introduced commercially.

Research equipment being installed inside MAXLAB's high-bay lab area.

MAXLAB construction was completed in September.

Clean Energy Highlights

ORNL clean energy research is making headlines. The following are examples

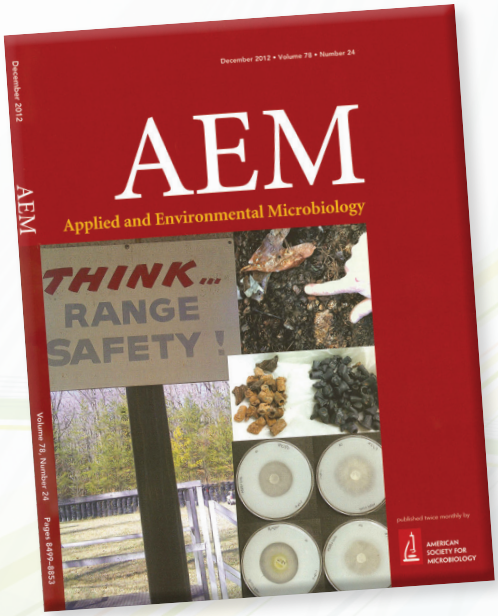
Graphics from an article by Biosciences Division's Terry Hazen, et al., appeared on the cover of the September 2012 issue of *Environmental Microbiology*. Co-authors include Julian Fortney of BSD. The article, "Deep-sea bacteria enriched by oil and dispersant from the Deepwater Horizon spill," is at http://onlinelibrary.wiley.com/doi/10.1111/j.1462-2920.2012.02780.x/abstract.

An article in the December 2012 issue of *Aviation Week & Space Technology* reveals how ORNL can serve as an extension of in-house research and development for the aerospace industry. The article takes a close look at ORNL's Manufacturing Demonstration Facility as well as the Spallation Neutron Source and the Carbon Fiber Technology Facility. http://www.ornl.gov/sci/manufacturing/docs/AW_12.17.2012.pdf

Turning lignin, a plant's structural "glue" and a by-product of the paper and pulp industry, into something more valuable is driving a research effort headed by Amit Naskar, Physical Sciences Directorate. In a cover article published in *Green Chemistry*, the research team describes a process that transforms the lignin by-product into a thermoplastic—a polymer that becomes pliable above a specific temperature. Other ORNL authors include PSD's Tomonori Saito, Rebecca Brown, Marcus Hunt, Deanna Pickel, Joseph Pickel, and Jamie Messman, and Energy and Environmental Sciences Directorate's Martin Keller. http://pubs.rsc.org/en/content/articlelanding/2012/gc/c2gc35933b

of studies and articles that earned cover-story status in recent months.

Photos submitted with an article in *Applied and Environmental Microbiology* by Biosciences Division's Tarah Sullivan and Chris Schadt's Strategic Environmental Research and Development Program project made the cover of the December 2012 issue. The article itself, "Firing range soils yield a diverse array of fungal isolates capable of organic acid production and Pb mineral solubilization," was published in the August 2012 issue. Read the original article at http://aem.highwire.org/content/78/17/6078.full.



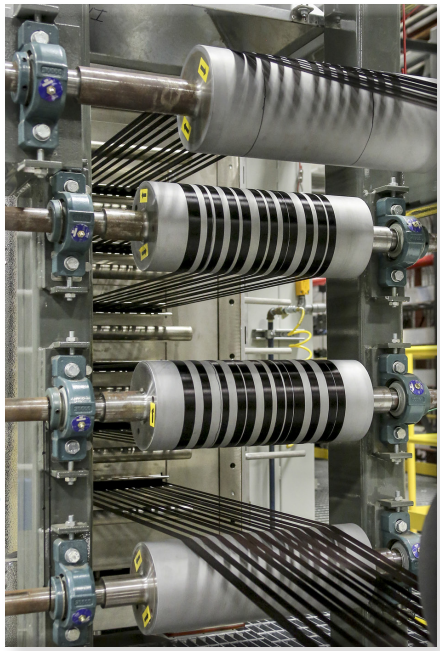
The cover of the January 2013 issue of *BioScience* features an image submitted by Biosciences Division's Jenny Morrell-Falvey of green fluorescent protein-expressing *Pantoea* (PMI strain YR343) on a plant root. The *Pantoea* strain was engineered by Amber Bible, a postdoc in Jenny's lab. A strain of engineered plant-associated *Pantoea* fluoresces green under laser light against a background of red autofluorescence from a wheat plant in the live confocal microscope image. The issue is available online at http://www.aibs.org/bioscience/current_issue.html

A graphic from an article by Biosciences Division's Aloke Kumar, titled "Opto-electrokinetic manipulation for high-performance on-chip bioassays," is the cover art on a December 2012 issue of *Lab on a Chip*. The article is available at http://pubs.rsc.org/en/content/articlelanding/2012/lc/c2lc40662d.

CFTF marks another milestone

January 15 was a big day for the Carbon Fiber Technology Facility. For the first time, technicians conducted a hot test of the oven system with a band of fibers moving through the ovens, thus producing a batch of "black" oxidized polyacrylonitrile fiber, or OPF. During this process, polymer fiber material makes multiple passes through each of four large (each approximately 30 feet long and 10 feet tall) ovens at temperatures between 200°C and 300°C. This turns the polyacrylonitrile fibers from white to black via chemical reactions that render the fibers flame resistant and enable them to withstand subsequent carbonization at much higher temperatures.

This milestone follows a very successful wrap-up of 2012. In December, the facility's operations team, working alongside equipment suppliers, completed all testing of individual unit operations (e.g., ovens, furnaces, materials conveyance systems) as well as a series of "cold runs" to verify continuous processing capabilities. And in October, ORNL hosted a meeting of the Oak Ridge Carbon Fiber Consortium, which now counts 44 member companies. New collaborations are in the works, and working groups are gaining traction.



Oxidized carbon fiber was produced during a hot test of the oven system.

Accelerating the automotive engine through high-performance computing

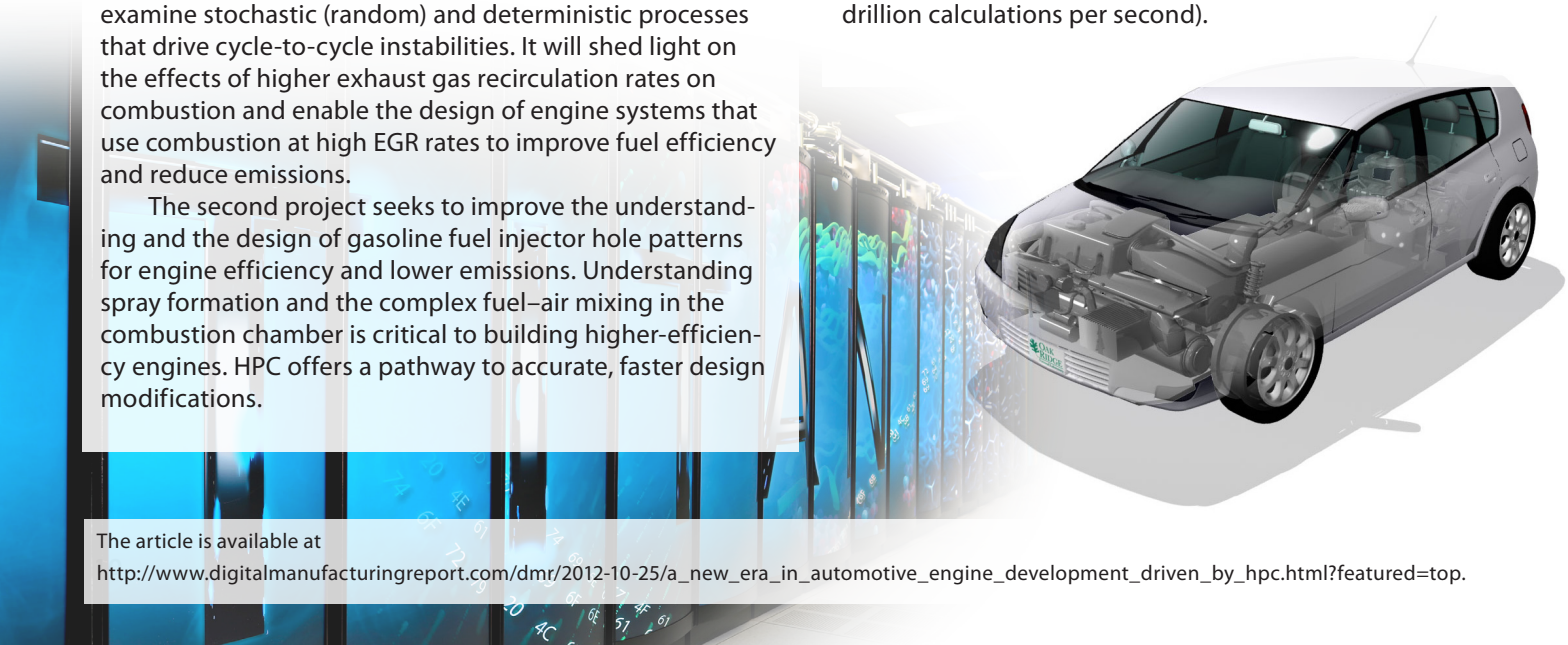
Modern automotive manufacturers are in pursuit of a more perfect internal combustion engine, designed to meet both consumer and regulatory demands for clean, efficient operation. In a recent online article, *Digital Manufacturing Report* journalist John Kirkley sheds light on two ORNL–industry collaborations benefiting from the lab's scientific and high-performance computing capabilities to advance engine design.

Both projects are funded through the DOE Vehicle Technologies Program Advanced Combustion Engine subprogram. The first uses high-resolution computational fluid dynamics modeling based on large eddy simulation to examine stochastic (random) and deterministic processes that drive cycle-to-cycle instabilities. It will shed light on the effects of higher exhaust gas recirculation rates on combustion and enable the design of engine systems that use combustion at high EGR rates to improve fuel efficiency and reduce emissions.

The second project seeks to improve the understanding and the design of gasoline fuel injector hole patterns for engine efficiency and lower emissions. Understanding spray formation and the complex fuel–air mixing in the combustion chamber is critical to building higher-efficiency engines. HPC offers a pathway to accurate, faster design modifications.

According to Robert Wagner of ORNL's Energy and Transportation Science Division, who contributed to the article, ORNL's HPC capabilities are "absolutely essential to making the breakthroughs necessary for accelerating advanced engine design and the ability of the automotive manufacturers to meet and surpass tomorrow's stringent emission regulations."

Already well positioned to address industry needs, ORNL enhanced its capabilities exponentially just days after the article was posted with the launch of Titan, the world's most powerful supercomputer for open science with a theoretical peak performance exceeding 20 petaflops (quadrillion calculations per second).



The article is available at
http://www.digitalmanufacturingreport.com/dmr/2012-10-25/a_new_era_in_automotive_engine_development_driven_by_hpc.html?featured=top.

Kickoff reveals new twists in robotics competition

Students from dozens of area high schools piled into ORNL's Manufacturing Demonstration Facility in early January to get a sense of the obstacles they will be battling over the next six weeks. Hundreds of students, parents, and mentors attended the kickoff event for the 2013 FIRST robotics competition, a nationwide event in which students design and build complex robots that can tackle the challenges of a specially designed game.

This year's challenge, which involves robots that can throw discs and climb pyramids, was revealed via simulcast during the event. Teams were then able to view a full-scale version of the competition field and hold mock games on it. The field, sponsored by Tech 2020 and assembled by the Hardin Valley Academy FIRST Alumni Club at ORNL's Manufacturing Demonstration Facility, or MDF, is available for all local teams to use during the build season.

Teams have six weeks to complete their robots before they face off in Knoxville's Smoky Mountains Regional at the end of March, with winning teams advancing to the national FIRST competition in St. Louis.

2013 FIRST robotics competition kickoff event.

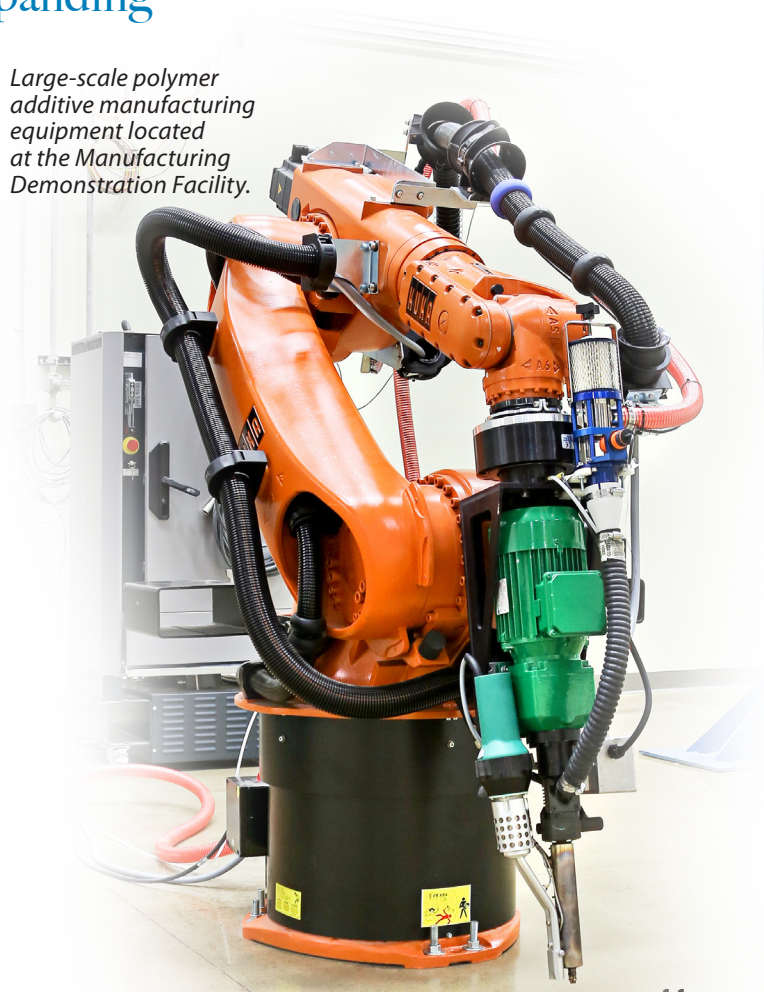
Additive manufacturing capabilities expanding

Additive manufacturing capabilities available through ORNL's Manufacturing Demonstration Facility are expanding to include large-scale polymer additive manufacturing and a new state-of-the-art Arcam A2XX system for metal additive manufacturing.

ORNL is working with industry to rapidly develop and demonstrate the additive manufacturing system for a fundamental breakthrough in high-flow-rate deposition of fiber-reinforced polymers at room temperature. Efforts will focus on integration of computer numerical control tooling to produce net shape components, integration of multiple materials, and development of integrated systems. Demonstration of rapid, low-cost tooling will impact a wide spectrum of industries, including automotive and aerospace.

The A2XX system is a robust platform providing 4× build volume. It has the potential to increase deposition rates by a factor of 4, with a target goal of 200 cm^3/hour. It also provides in situ process monitoring of each layer deposited for porosity and defect detection and for verification of part quality. It is expected to be operational in January.

ORNL is currently working on parameters for depositing Inconel alloys for high-temperature aerospace applications. Under a collaboration with Arcam to advance metal additive manufacturing, this work will be applied to in situ process monitoring and work with Arcam to evaluate the technology.



Large-scale polymer additive manufacturing equipment located at the Manufacturing Demonstration Facility.

Making Connections

- In December, US Representative Chaka Fattah visited the Oak Ridge Leadership Computing Facility, Bioenergy Science Center, Spallation Neutron Source, Center for Nanophase Materials Sciences, and Manufacturing Demonstration Facility. He spoke with lab leaders about ORNL's research in areas including advanced manufacturing, materials research, supercomputing, and biofuels; transfer of ORNL technology to the private sector; and science, technology, engineering, and math education.

US Representative Chaka Fattah signs ORNL's Cray X1E supercomputer, Phoenix.

- ORNL hosted guests from DOE, Chrysler, and Nemak in late November to kick off a new advanced aluminum project. The event included tours of ORNL facilities on the main campus as well as the Spallation Neutron Source, National Transportation Research Center, and Manufacturing Demonstration Facility.

Advanced aluminum kickoff attendees.

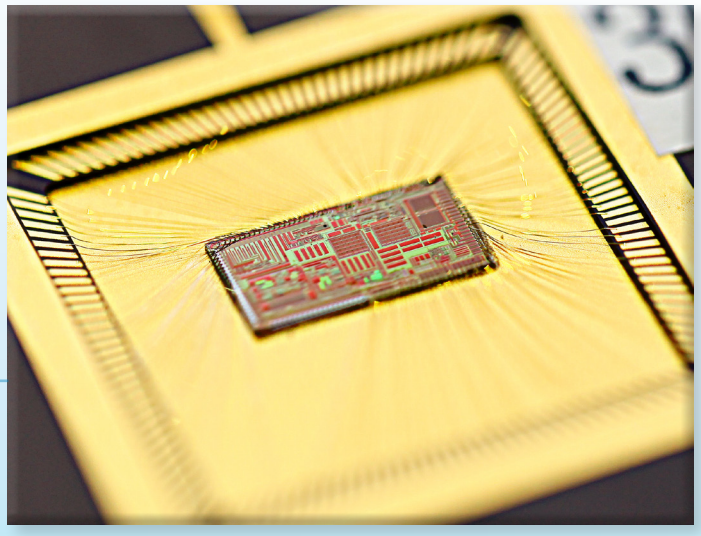
- Lonnie Love and Randy Lind of Measurement Science and Systems Engineering Division worked with Massachusetts Institute of Technology's Lincoln Laboratory to assess problems during the recent massive upgrade of the 1960s Haystack Antenna. When powered up, the antenna experienced uncontrolled vibration that rendered it inoperable. ORNL worked with MIT engineers to determine that air in the hydraulics was the source of the problem and provided guidance on minor hydraulic modifications to ensure the problem would not reoccur.

- Energy and Transportation Science Division's Diane Davidson was interviewed by *Knoxville News Sentinel* reporter Matt Lakin for an article in the newspaper's continuing "decades" series about life in Knoxville. Diane addressed the transportation trends in East Tennessee in the foreseeable 10-year future, including mobility options for commuters and sustainability issues in the Tennessee Valley.

The article can be found here:
http://www.knoxnews.com/news/2012/dec/23/all-the-right-moves-needed-in-education-industry/

Diane Davidson

- Energy and Transportation Science Division hosted a workshop to gauge state-of-the-art capabilities and opportunities in wide band gap research and development for automotive traction drive applications. About 40 representatives from industry, universities, and national labs attended the event and toured the National Transportation Research Center and the Manufacturing Demonstration Facility.



Silicon-on-insulator universal gate drive chip developed by ORNL for wide band gap devices capable of operating at temperatures from –55 to 200°C.

- In late November, Energy and Environmental Sciences Directorate representatives helped host meetings with Nobuaki Kato, DENSO Corporation Global President, and eight senior DENSO representatives. The visit included tours of ORNL and National Transportation Research Center.

DENSO reps view wireless charging technology.

- Lee Slezak and David Anderson of the DOE Vehicle Technologies Program and Jason Conley of National Energy Technology Laboratory visited ORNL for the official kickoff of the Wireless Power Transfer and Charging of Plug-in Electric Vehicles project. Representatives from project partners Evatran, Clemson University, and General Motors also attended. The event included presentations by Energy and Transportation Science Division's David Smith and John Miller.

- Energy and Transportation Science Division's Nasr Alkadi moderated a panel titled "Deployment of wireless sensor networks for industrial energy efficiency" during the Future of Instrumentation International Workshop in Gatlinburg in October. The panel was attended by four partners of the DOE Advanced Manufacturing Office's Better Buildings, Better Plants program: Bridgestone-Firestone, Nissan North America, Raytheon, and Saint Gobain.

- The Society of Manufacturing Engineers Knoxville chapter toured the Manufacturing Demonstration Facility for an overview of emerging technologies in manufacturing, including additive manufacturing and robotics. SME is the premier source for manufacturing knowledge, education, and networking and is a leader in manufacturing workforce development issues, working with industry, academic, and government partners to support a skilled workforce.

SME reps tour Manufacturing Demonstration Facility.

Employee Excellence

- Energy and Transportation Science Division's Robert Wagner and Brian West have been elevated to Fellow status in the Society of Automotive Engineers. The SAE Fellows Committee noted Robert's distinctive contributions in combustion stability fundamentals and the scaling and harmonization of low-temperature combustion processes to multi-cylinder engines. Brian's selection is attributed to outstanding research accomplishments impacting multiple national fuel policies and sustained, unique contributions to technology and data supporting improved vehicle fuel economy. They will be honored during the SAE World Congress and Exhibition in Detroit in April.

Robert Wagner

Brian West

- Gary Sayler, director of the Joint Institute for Biological Sciences, has been elected a fellow of the American Association for the Advancement of Science. Gary will be recognized for his contributions to science and technology at the Fellows Forum in February during the AAAS Annual Meeting in Boston.

- Energy and Transportation Science Division's André Desjarlais received a Lifetime Achievement Award from the Polyisocyanurate Insulation Manufacturers Association during its 25th anniversary celebration in Washington, D.C. PIMA board chairman Chris Griffin said, "André's dynamic, experimental, and analytical methods have been instrumental in the advancement of polyiso insulation and, more important, in building thermal performance."

- Environmental Sciences Division's Liyuan Liang received a 2012 ORNL award for Research and Development Leadership at the group level for "her leadership in aligning subsurface science in ESD with DOE priorities; creating an environment that promotes staff hiring, development, and high-impact publication; and providing strategic direction that has resulted in programmatic growth and cross-division collaboration."

Liyuan Liang

- Energy and Transportation Science Division's David Greene is the 2012 recipient of the Transportation Research Board's Roy W. Crum Distinguished Service Award. An ORNL Corporate Fellow, David is recognized for his significant contributions to research on transportation energy and related issues.

- In late November, Energy Secretary Steven Chu announced funding of several new Advanced Research Projects Agency–Energy projects. ORNL will work with project lead Georgia Tech and nGimat Company to develop a supercapacitor using graphene, a two-dimensional sheet of carbon atoms, to store energy at 10 times greater density than current technologies. Supercapacitors store energy similarly to a battery but charge and discharge much more rapidly. Energy and Transportation Science Division's Michael Hu leads ORNL efforts on this project.

- In January, Energy and Transportation Science Division's Sujit Das began serving a two-year term as chair of the SAE Engineering Meetings Board's Sustainable Development Program Committee.

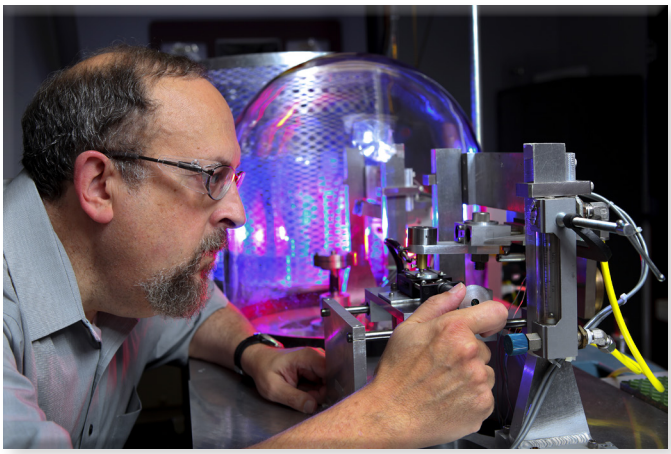
Sujit Das

- Congratulations to Energy and Transportation Science Division's Mahabir Bhandari, who was elected for a three-year term to the Board of Directors of National Fenestration Rating Council, a nonprofit organization that administers the only uniform, independent rating and labeling system for the energy performance of windows, doors, skylights, and attachment products.

- Congratulations to Energy and Transportation Science Division's Manfred Kehrer and others who contributed to the success of WUFI, a software package for verifying the moisture durability of building envelope assemblies. Co-developed by ORNL and Fraunhofer Institute of Building Physics, WUFI was named one of the 2013 Top 10 Green Building Products by BuildingGreen, Inc., at the 2012 GreenBuild International Conference and Expo.

- Ranjeet Devarakonda of Environmental Sciences Division's agreed to become a member of the editorial board for the journal *Earth Science Information*.

Ranjeet Devarakonda



Peter Blau

- Peter Blau, Materials Science and Technology Division, has been appointed co-editor-in-chief of the international journal *Wear*. Founded in 1957, the journal's scope encompasses all aspects of physics, chemistry, materials science, and mechanical engineering that relate to wear and frictional phenomena.

- Congratulations, ORNL mentors and Lab RATS (Robots Are Technology in Service)! With 245 points, the RATS wrapped up the 2012 FIRST®LEGO® League competition in Cookeville, Tenn., ranking 9th of 59 teams in robot performance and placing 1st in the category of Gracious Professionalism. The students met twice weekly with ORNL mentors and members of the Hardin Valley Academy FIRST Robotics team last fall at the National Transportation Research Center/Manufacturing Demonstration Facility to prepare for the competition that targets students ages 10 to 14.

Congrats, RATS!!!

Energy & Environmental Sciences Quarterly is published four times annually by Oak Ridge National Laboratory's Energy & Environmental Sciences Directorate.

Website: *http://www.ornl.gov/sci/ees/*

Managing Editor: Suzy Fowler

Editorial Team: Kathy Graham, Meghan Drake, Penny Humphreys, Jennifer Palmer, and Deborah Counce.

Designer: Lindsey Marlar

To submit news, information, or suggestions, please email eesquarterly@ornl.gov.

Oak Ridge National Laboratory is operated by UT-Battelle for the U.S. Department of Energy under contract DE-AC05-00OR22725.

Energy & Environmental Sciences
P.O. Box 2008
Oak Ridge, TN 37831-6186

Quality Counts...

ORNL research published in highly ranked science and technology journals is a major contributor to establishing and maintaining an outstanding reputation for the Laboratory with its sponsors, customers, the research community, and the public.

According to the international Peer Review Survey 2009 conducted by Sense about Science,

- 78% of authors (n=4037) had their most recent paper rejected by their first choice scientific journal
- 91% had to revise their article prior to publication, but all acknowledged the peer review process revisions improved the quality of their paper

ORNL early career researchers and senior scientists improve their publishing success rate by using the Lab's Publications Tracking System (PTS) to receive internal peer review feedback before journal submission.

ORNL PTS ... an example that Quality Counts in everything we do.