

CRADA with GM reveals a stronger diesel filter

Working under a Cooperative Research and Development Agreement (CRADA), General Motors and ORNL researchers are unraveling why diesel particulate filters (DPFs) often perform better than models predict. In a study overview delivered at the 2011 DOE Directions in Engine Efficiency and Emissions Research Conference, ORNL researchers reported that measurements revealed the apparent elastic modulus of DPF ceramics to be almost an order of magnitude lower than industry-accepted values.

“The measurements indicate that while the filter is under thermally-induced strain, such as when cleaning

during regeneration, the actual internal stresses are much lower and mechanical reliability is much higher than manufacturer models have predicted in the past,” said Andrew Wereszczak, Materials Science and Technology Division (MSTD), explaining that excessive stress can cause cracking and DPF failure. With the new information, he added, “Manufacturers can more accurately model performance and expect longer service lifetimes than ever before.”

Andrew and MSTD’s Michael Lance are leading ORNL’s efforts, with assistance from MSTD’s Ethan Fox. Additional confirmation testing is ongoing.

ORNL aboard Coast Guard project

ORNL researchers are helping guide the United States Coast Guard (USCG) through unchartered waters. Applying expertise in fuels and engines research, the lab is supporting the military organization’s new mandate to increase use of alternative fuels in their marine fleet.

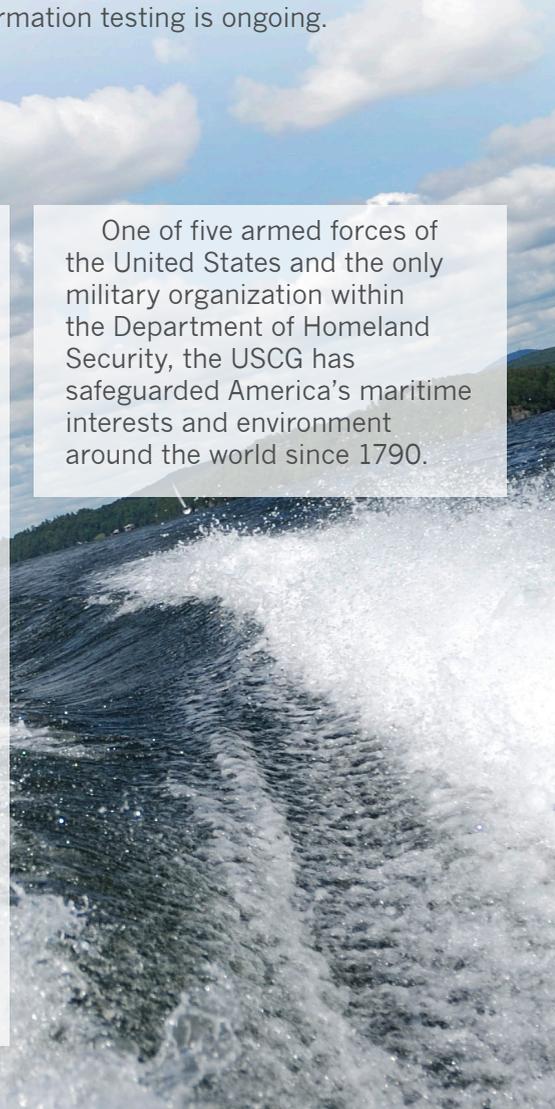
“The Coast Guard has decided to use biobutanol rather than ethanol to mix with gasoline in their smaller craft, and biodiesel rather than petroleum diesel in their larger engines,” explained Energy and Transportation Science Division’s (ETSD’s) Tim Theiss, group leader with the Fuels, Engines, and Emissions Research Center. Tim and ETSD’s Jim Szybist and Brian West are serving as subject matter experts on the three-year project led by USCG Research and

Development Center with the marine engine manufacturers Mercury, Honda, and Cummins, and implementation partners.

Until now, ORNL fuels and engines research projects have concentrated primarily on “dry land” transportation applications powered by gas, diesel, and ethanol blends. In addition to evaluating biodiesel, the USCG project concentrates on the performance benefits of using butanol in gas engines.

“Butanol does not mix with water as much as ethanol does, which makes it preferable to the Coast Guard for marine applications,” explained Tim. The project also explores the maximum acceptable level of these renewable fuels with the marine engines and infrastructure materials while operating in a saltwater environment.

One of five armed forces of the United States and the only military organization within the Department of Homeland Security, the USCG has safeguarded America’s maritime interests and environment around the world since 1790.



ORNL named in ARPA-E and other DOE projects

Just weeks after being named lead or supporting partner in 13 new projects to advance next-generation vehicles, ORNL is adding four more DOE-funded projects to the lab's transportation research portfolio. The projects, summarized here, will benefit from the capabilities and expertise of the Fuels, Engines, and Emissions Research Center (FEERC), Advanced Power Electronics and Electric Machinery Research Center (APEEMRC), and High Temperature Materials Laboratory (HTML).

- ORNL will support a DOE Advanced Research Projects Agency-Energy (ARPA-E) project led by Texas AgriLife Research that will address a major inefficiency of photosynthesis, the process used by green plants to capture light energy. Specifically, the team will redirect otherwise wasted energy in plants into energy-dense fuel molecules. The fuel will be readily separated from the plant biomass through distillation. Energy and Transportation Science Division's (ETSD's) Bruce Bunting, FEERC, leads ORNL efforts.
- ARPA-E project leader QM Power, ORNL, and other partners will build a motor that uses no rare earth materials and is light, compact, efficient, and powerful. Key innovations in this project include the use of a new motor design, addition of emerging materials, and the incorporation of advanced manufacturing techniques that substantially reduce costs. ETSD's John Miller, APEEMRC, leads ORNL efforts.
- In a third ARPA-E project, ORNL and project lead, University of Minnesota, will aggressively develop an early stage prototype of bulk iron-nitride permanent magnet material. This new material has the potential to be the "holy grail" of magnets as the highest energy density magnet from earth abundant raw materials. This project will provide the basis for an entirely new class of rare earth-free magnets for electric vehicle and wind turbine applications capable of eliminating the need for costly and scarce rare earth materials. The ultimate goal of this project is to demonstrate magnetic properties on a prototype bulk magnet exceeding state-of-the-art commercial magnets. Materials Science and Technology Division's Edgar Lara-Curzio, Larry Allard, and Mike Brady lead ORNL efforts in this project.

- In addition to the ARPA-E projects, ORNL will be supporting project lead Filter Sensing Technologies, Inc., in the development and demonstration of low-cost, robust sensors, and controls that can reduce the overall cost and complexity of engine and emission control systems while delivering tangible performance benefits. The initial focus will be on U.S. heavy-duty vehicles. ETSD's Jim Parks and John Storey, FEERC, lead ORNL efforts.

New capability at HTML

An advanced, dual-sensor, multi-axis stylus profiling system to measure and map fine-scale surface features in either 2D or 3D has been installed in HTML's Tribology Research User Center (TRUC). The new NanoMap instrument, purchased by the HTML User Program, adds the ability to accommodate larger, rougher test specimens and will aid in the failure analysis of bearings, gears, and other relatively large specimens. The new instrument is expected to significantly complement surface characterization capabilities and support TRUC research with its user-friendly profiling system.



Materials Science and Technology Division's Bob Norris, left, was among ORNL researchers who met with Volkswagen officials in August to discuss the lab's advanced materials research.



DOE's Peter Faguy, Vehicle Technologies Program, met with ORNL researchers in September to learn more about the lab's advanced battery research program. Pictured left to right, Materials Science and Technology Division's David Wood discusses the lab's slot-die coater technology with Peter and Sustainable Transportation Program's Ron Graves and Claus Daniel.

Engine experiments validate ORNL-developed alternative fuel

ORNL scientists and engineers have developed a unique approach to producing hydrocarbons with gasoline-like qualities.

"This path to more fungible "drop in" fuel blending material begins with ethanol or fermentation stream from renewable biofeedstocks such as switch grass or hardwood," said Materials Science and Technology Division's Chaitanya Narula.

Using a bench flow reactor, Chaitanya recently converted ethanol to a hydrocarbon blend using a low-cost metal-exchanged zeolite catalyst to produce experimental fuel. He then bottled and passed along 250 mL of the fuel to Energy and Transportation Science Division's Jim Szybist.

With the fuel, Jim operated a single-cylinder engine inside the Fuels, Engines, and Emissions Research Center at NTRC. "Though performed on a small scale, the experiments help validate that the fuel produces engine performance comparable to gasoline," said Jim.

While studies are continuing, both researchers agree that the results demonstrate a very real opportunity to overcome the "Blend Wall" by eliminating the limits imposed on the use of ethanol as a transportation fuel.

Milestone validates low-cost plastic as potential carbon fiber precursor

Polyethylene, the most commonly used plastic, is showing promise as a precursor for low-cost carbon fiber. In late September, a team from the Materials Science and Technology Division (MSTD) prepared a polyethylene-based carbon fiber with tensile properties of 200 ksi strength and 20 Mpsi modulus, meeting the team's FY2011 research goal.

"The research proves that polyethylene can make a rigid and strong carbon fiber, and reveals promising opportunities for using non-conventional polymeric precursors in low-cost carbon fiber manufacturing," said team leader Amit Naskar.

Marcus Hunt, Tomonori Saito, and Joshua Perkins designed and performed the precursor stabilization and carbonization experiments. Ken Yarborough helped the team with operating the high temperature furnace. Laura Poland and Marcus Hunt conducted tensile testing.

"Controlled thermochemical processing and pyrolysis helped the team to improve the modulus of the carbonized filaments from functionalized precursor fibers," said Amit, adding that there's still much work to do. The team will be working towards optimizing the stabilization time and condition through FY2012, while other ORNL research groups and the industrial partner will be evaluating the scalability and economics of the processes.



General Motors officials visited ORNL main campus and NTRC recently, where they toured and received briefings on the lab's transportation portfolio and more. Pictured left to right, ORNL Energy Partnerships Director Ray Boeman, GM's Thomas Nehl and Nady Boules, and Energy and Transportation Science Division's John Miller discuss the wireless power transfer technology under development at NTRC.



Energy and Transportation Science Division's Burak Ozpineci discusses ORNL's power electronics and electric machinery research with Patricia Hoffman, Assistant Secretary for the DOE Office of Electricity Delivery and Energy Reliability, who visited ORNL facilities in October.

ORNL, Caterpillar complete CRADA on fuel injector materials

Working with Caterpillar Inc., ORNL has completed a Cooperative Research and Development Agreement (CRADA) including a comprehensive study of the microstructures, nano-mechanical properties, residual stresses, and fatigue of an alloy steel used for fuel injector nozzles that contain fine spray holes. One of the more significant findings of this CRADA was that the current steel experiences a transition in fatigue crack initiation behavior above a critical applied stress. This has implications for both the metallurgical cleanliness of the steel as well as the surface finish placed on stressed regions of the component. A final report has been submitted for review and publication. Materials Science and Technology Division's Peter Blau served as PI for the CRADA.

Do you have news or information you would like to share?

Please submit to Kathy Graham,
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865-946-1861 or grahamkj@ornl.gov

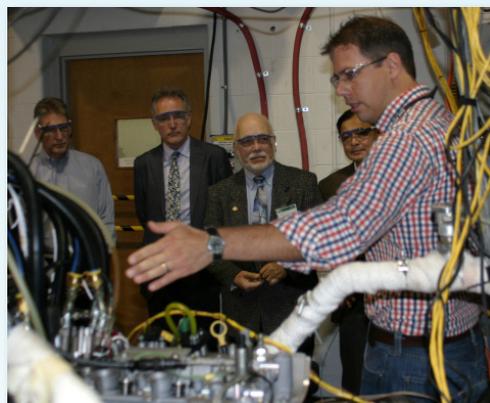
ORNL hosts BioBaler demonstration

ORNL recently hosted a field day at the University of Tennessee (UT) Arboretum to foster information exchange about the BioBaler harvesting system. In a single pass with a single operator, the BioBaler can cut and compact biomass into a dense round bale. The bales can then be transported to a power plant or other facility for processing into fuel.

Demonstration attendees included more than 40 state, federal, and private industry representatives interested in economical ways of converting woody products into biomass fuel. ORNL, UT, USDA Forest Service, Tennessee Division of Forestry, Genera Energy, and Domtar Paper representatives were on hand as well as BioBaler manufacturer, the Anderson Group. Environmental Sciences Division's Matt Langholtz, who coordinated the ORNL effort, offered special thanks to the University of Tennessee Forest Resources Research and Education Center for collaboration on this project.



BioBaler system in operation.



Underwriters Laboratories and Butamax officials visited ORNL in September to learn more about potential compatibility issues between isobutanol blended gasoline and infrastructure materials. Pictured here, Energy and Transportation Science Division's Jim Szybist, right, talks with the visitors in an engine lab at NTRC.

Honors & Highlights



Steve Whitted

- Congratulations to all Awards Night winners, with special recognition to winners supporting ORNL transportation research efforts. Steve Whitted, Energy and Transportation Science Division, is being recognized for excellence and innovation as an automotive research mechanic in supporting and leading research staff in the Fuels, Engines, and Emissions Research Center. David Wood, Materials Science and Technology Division, is being recognized for producing high-impact research results related to the development of high-performance battery materials and their implementation into commercial processes. Complete information about this year's Awards Night winners is available on ORNL Today. Awards Night, which will include the announcement of the Director's Award winners, will be held on Nov. 11.



David Wood

- Through a competitive bidding process, ORNL has awarded the design and construction of a one-of-a-kind dry room facility at NTRC-2 to Scientific Climate Systems. The dry room will house a semi-automated cell assembly system and provide prime space for battery cell manufacturing research and development.
- Energy and Transportation Science Division's Steve Gordon has reached two milestones related to the Intelligent Transportation Systems Deployment Tracking Survey. His report, Deployment of ITS: A Summary of the 2010 National Survey Results, has been published as a DOT document and is now posted in the DOT National Transportation Library at ntl.bts.gov/lib/42000/42100/42130/Deploy_of_ITS..._2010_Natl_Survey_final.pdf. Steve also completed the new ITS Deployment Tracking web site in which the results of the 2010 survey are posted. After a final review by the sponsor, it will replace the current site (with 2007 results) at www.itsdeployment.its.dot.gov/.
- Special thanks to the many researchers who participated in the 2011 DOE Directions in Engine Efficiency and Emissions Research (DEER) Conference, the well-known meeting organized each year

by DOE's Vehicle Technologies Program. ORNL delivered more presentations than any other single organization. The strong showing at this meeting highlights the importance and breadth of the ORNL transportation research portfolio and relevance to the technical issues facing the transportation industry as a whole.

- Energy and Transportation Sciences Division's Diane Davidson has been elected to a two-year term on the Intelligent Transportation Society of Tennessee (ITS Tennessee) Board of Directors. ITS Tennessee is a state chapter of ITS America.
- Energy and Transportation Science Division's Simon Rose has received \$1,000,000 to support ongoing technical work in support of the DOT Pipeline and Hazardous Materials Safety Administration. Simon manages the ORNL pipeline safety program that has a number of active tasks involving staff from different disciplines across ORNL.
- Gui-Jia Su and Lixin Tang, Power Electronics and Electric Machinery Research Group, were awarded the Best Paper Prize at the 7th IEEE Vehicle Power and Propulsion Conference (VPPC 2011) for their paper, "Current Source Inverter Based Traction Drive for EV Battery Charging Applications."
- Energy and Transportation Science Division's Rick Goeltz has been reappointed to another two-year term as chair of the Transportation Research Board technical expert task group Design and Implement a System for the Archiving and Disseminating Data from SHRP 2 Reliability and Related Studies (L13A). The group will be reviewing the work performed by Berkeley Transportation Systems, Inc.
- The Office of Highway Policy Information of the Federal Highway Administration (FHWA) tasked ORNL's Center for Transportation Analysis with formulating a new methodology to estimate the national fuel economy rates (miles per gallon) for passenger cars, as well as light, medium, and heavy duty trucks. The purpose of the new methodology is to ensure that total vehicle miles traveled, number of vehicles, and total fuel consumption statistics are both consistent and reasonable. Energy and Transportation Science Division's Shih-Miao Chin was the project investigator for this significant work. The methodology has been published as Table VM-1, in Highway Statistics. The FHWA's news release for this event can be found at <http://www.fhwa.dot.gov/pressroom/fhwa1155.htm>.