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Northwest Alliance for Transportation Technologies

Making Diesel a Good Neighbor

Diesel engine manufacturers and car and truck makers are making great strides in developing newer engines that are more fuel-efficient, quieter and produce fewer emissions. Extending these efforts, partners in the Northwest Alliance for Transportation Technologies (NATT) are helping provide even cleaner air by developing technologies to further reduce pollutants emitted from diesel-powered vehicles.

Pacific Northwest National Laboratory (PNNL) and its industry partners developed a new pollution-reducing technology called a non-thermal plasma-assisted catalysis system to help car and truck manufacturers meet federal diesel engine emission regulations set to take effect by 2007.

This new plasma-catalyst system, developed by PNNL researchers and partners, converts oxides of nitrogen (NOx), a key contributor to smog, and particulate matter emissions into components of clean air. NOx emissions potentially pose health risks and contribute to the formation of acid rain and ozone depletion.

In September, the catalyst materials for this technology earned an R&D 100 award by R&D Magazine. This award-winning research is the result of partnerships between PNNL, Ford Motor Co., Delphi Automotive Systems, Caterpillar, DaimlerChrysler and General Motors, along with the efforts of team leaders Chris Aardahl, Darrell Herling and Chuck Peden at PNNL.

According to Peden, "The plasma-catalyst system holds advantages over other emission-control devices because it does not require high exhaust-gas temperatures, isn't poisoned by sulfur and may not need additional fluids, such as a urea solution used for selective catalytic reduction systems."

The main challenge facing the commercialization of the plasma-catalyst technology, says Aardahl, "is decreasing the energy requirements of the plasma reactor and increasing the conversion efficiency of the advanced catalyst materials."

"Through this research by NATT partners, we've achieved more than 30 percent reduction in particulate matter and a 55 percent reduction in NOx emissions," said Herling. "This puts the industry within the window to meet off-road emission requirements, and moves them toward meeting 2007 on-highway targets."

R&D Magazine's R&D 100 award winners from PNNL are from left to right: Russ Tonkin, Steve Barlow, Suresh Baskaran, and Darrell Herling (seated). Not shown are Mary Lou Balmer-Miller and Alex Panov (Caterpillar), John Hoard (Ford) and Galen Fisher (Delphi).

The research is funded by DOE's Office of Transportation Technologies, Combustion and Emission Control Programs. Research continues with Delphi Automotive Systems' development and commercialization of an engine exhaust after-treatment system for diesel-powered vehicles.

In This Issue:

From the Driver's Seat

By Mark T. Smith, NATT Director

The increasing importance of energy's role in the U.S. economy makes our work here at the Northwest Alliance for Transportation Technologies more challenging than ever. NATT's continuing research in lightweight materials and manufacturing technologies positions us extremely well to assist President Bush's FreedomCAR program, announced recently by Energy Secretary Spencer Abraham to help develop fuel cell cars that run on hydrogen. The shift to a hydrogen-based transportation economy means we must redouble our efforts in the materials sector to "lighten the load" in order to maximize hydrogen's benefits.

The Pacific Northwest National Laboratory and its industry partners continue to produce world-class research in our efforts to improve vehicle energy performance. In this issue, you'll read about our work to reduce emissions from diesel vehicles and develop advanced manufacturing processes for metal matrix composites, lighter-weight automotive glass and SUV frames. This past year, R&D Magazine recognized our emission reduction research with an R&D 100 award that honors the world's most promising new products, processes, materials and software. (See "Making Diesel a Good Neighbor, page 1)

NATT partnerships among auto manufacturers, material suppliers, truck makers and universities provide an interdisciplinary approach to technology and materials as we help attack the nation's transportation goals. Finally, preliminary planning has already begun for NATT's fall workshop in Seattle and we look forward to discussing all of this and more with you there. Program details will be on their way soon so you can mark your calendars. Thank you for your ongoing participation, interest and support of NATT.

NATT

Framing Success for Fuel Efficiency

The 400-pound vehicle frame of a Dodge Durango received reconstructive surgery and lost some weight last year in a joint "operation" conducted by PNNL and NATT.

Almost half of all new vehicle sales in the United States are pickups, SUVs and vans. On average they weigh more, are less fuel-efficient and present safety problems when they collide with lighter vehicles.

Reducing frame weight by 30 percent while maintaining vehicle performance was a goal of the NATT-PNNL partnership, which also included DaimlerChrysler, DOE's Office of Heavy Vehicle Technologies and Alcoa, the world's largest aluminum producer.

New lighter-weight frames for SUVs and pick-ups will improve their fuel efficiency and environmental performance when they reach the marketplace four-to-five years from now.

Phase I design feasibility studies completed in 2000 indicated potential weight and cost savings using a hybrid of steel and aluminum. Based on these initial findings, PNNL initiated Phase II last year, involving cost projections and development of three prototype frames.

The three prototypes are now completed and ready for performance testing at the DaimlerChrysler proving grounds this year. Testing will include mounting the chassis on a 2002 Dodge Durango and driving it under rugged, real-world road conditions.

"We did not quite meet our goal of 30 percent weight reduction, but we came very close," said Mark Smith, Technical Group Manager for PNNL. "Successful tests in the coming months will give DaimlerChrysler the confidence it needs to consider these materials in new vehicle development."

Ongoing testing will be designed to show that durability, crash-worthiness and functionality are not compromised for lighter-weight and more environmentally sustainable materials.

In a related effort, PNNL also contracted with Alcoa Automotive Engineering to design a preliminary concept for an all-aluminum frame. The Alcoa design features a projected weight savings of 187 pounds, 50 percent more than that of the hybrid frame.

"The most significant result of our preliminary designs was the potential weight and cost savings for an all-aluminum frame," said Todd Summe, product development engineer at Alcoa. Alcoa's advanced concepts, if successful, would produce higher rewards by integrating weight, cost, and fuel and emissions savings with performance needs.

DaimlerChrysler's 2002 Dodge Durango ©

Eliminating Barriers to Aluminum Metal Matrix Composites

Partners in the Northwest Alliance for Transportation Technologies (NATT) are moving automotive component manufacturing processes another step closer to practical street application.

Appealing because of their low density and high strength, aluminum metal matrix composites (MMCs) are making their debut in consumer products and prototypes, but prohibitive costs and difficult manufacturing processes continue to pose a challenge, especially for cost-sensitive markets such as the automotive industry. NATT partners are helping address these challenges for transportation applications by using a new, low-cost aluminum metal matrix composite product made possible by a novel rapid mixing manufacturing process.

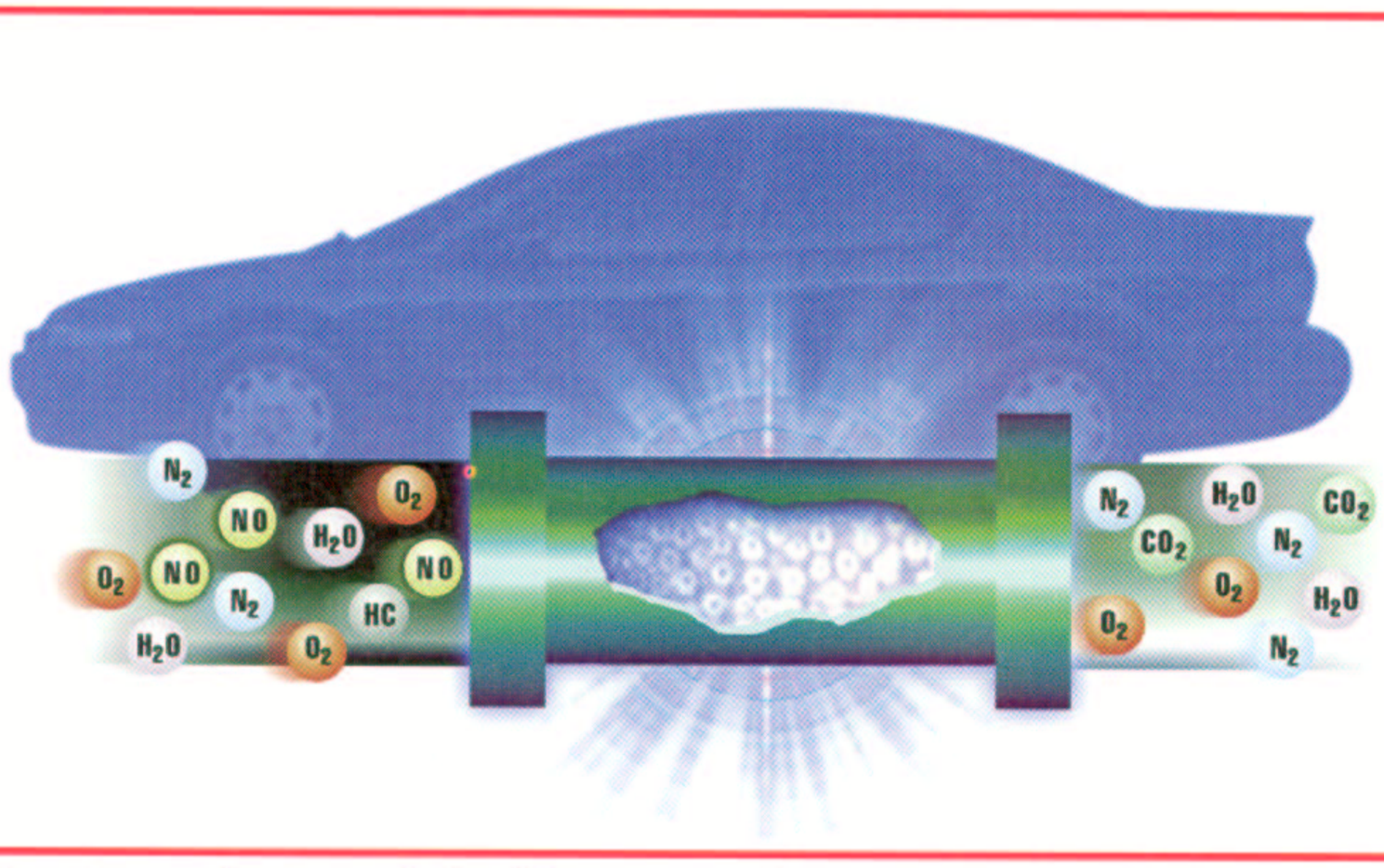
"Aluminum MMCs are an attractive option for automotive and truck drivetrain components because of their inherent strength, rigidity and wear resistance. Yet they are still lighter than steel or iron components," said Darrell Herling, senior development engineer at PNNL.

Using an automotive brake rotor as a demonstration product, NATT partners focused on producing prototype components employing a low-cost aluminum MMC material with ceramic-particle reinforcement. With the help of a new mixing system designed and built by MC-21 Inc., the low-cost aluminum MMC material costs only $1 per pound to produce. Herling said the $1 per pound production cost is an industry cost target for such a material and therefore meets a goal for the project. In addition to MC-21 Inc., project partners included Aluminum Consultants Group, Eck Industries, Pacific Northwest National Laboratory, Oak Ridge National Laboratory, Rockwell Science Center and USAMP partners (DaimlerChrysler, Ford Motor Co. and General Motors).

MC-21's new modular mixing system can mix ceramic reinforcement into the molten aluminum metal in significantly less time than that required by other MMC production methods.

The key to the team's success was the design of a system that can mix the ceramic reinforcement into the molten aluminum metal in significantly less time than required by other MMC production methods. MC-21's modular mixing system design includes a furnace to melt the aluminum alloy, with a specially designed mixing unit and a holding furnace that keeps particles suspended in the molten aluminum at a constant temperature while waiting to be cast into parts.

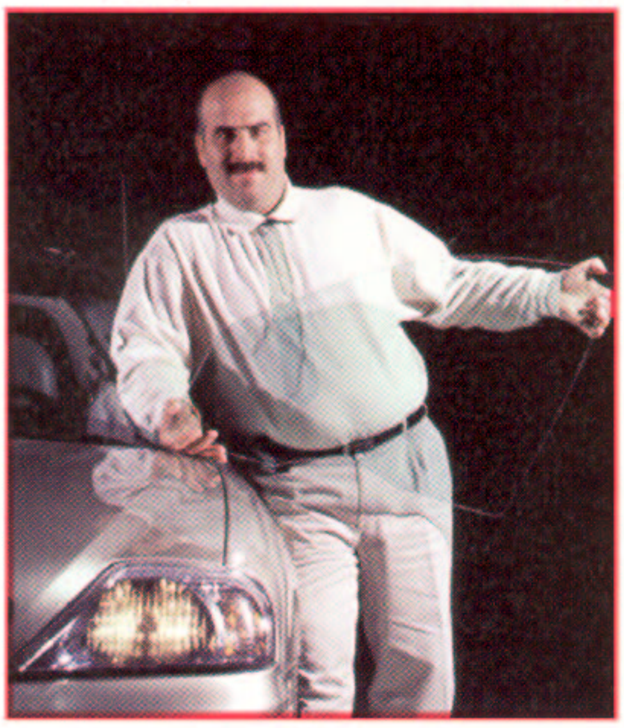
NATT will now focus its research for this project on downstream secondary manufacturing costs, such as developing more efficient casting and finishing processes for aluminum MMC components, in order to further reduce part costs.



New plasma-catalyst system developed by PNNL researchers and partners convert oxides of nitrogen (NOx) into components of clean air improving diesel emission performance. (See story, page 1).

Automotive Glass Loses Weight, Tones Up

Glass went on a weight-loss program this year with the help of NATT researchers. On average, a family sedan carries 100 pounds of glass, contributing to overall energy consumption and vehicle emissions. Glass is expected to become even more prevalent in new consumer vehicles as automotive designers increasingly incorporate it as a luxury item, so its weight contribution is an ongoing concern.



Moe Khaleel, senior staff engineer and PNNL technical group leader holds lighter prototype windshield.

In 2001, researchers explored ways to meet targets established by the Partnership for a New Generation of Vehicles (PNGV) for lighter-weight glass, while maintaining structural integrity and low costs. Partners on the project, funded by the Department of Energy, included the Pacific Northwest National Laboratory, Pittsburgh-based glass manufacturer PPG Industries Inc., Michigan-based automotive technology supplier Visteon Corp., and Ford Motor Co.

A secondary objective for the project was to provide analytical tools to aid in the design of lightweight glass alternatives.

A windshield, the focus of initial glass research, presents significant challenges with its optical requirements, thermal properties and safety needs.

"With the development of a 30 percent lighter prototype windshield that retains its structural integrity, we continued to meet both project and PNGV goals during our fourth year on the project," said Moe Khaleel, senior staff engineer and technical group leader at PNNL. "In the process, we were also able to develop new computational models and testing tools to assess structural integrity."

Testing primarily focused on three key areas: static strength, impact resistance and torsional rigidity. For example, lighter-weight glass must be designed to withstand normal road conditions such as gravel impact, the sun's infrared rays and stress from potholes.

"Most people don't realize how much glass contributes to the overall structure of a car – it contributes 32 percent to overall rigidity and 30 percent to resisting roof crash," said Khaleel.

In the coming year, glass research will increasingly focus on special coatings, such as those that reflect infrared rays, and will move beyond windshields to address side and rear windows.

We plan to keep you updated on NATT happenings through NATT Quarterly. If you have any news we should know about, contact Mark Smith at (509) 376-2847.

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