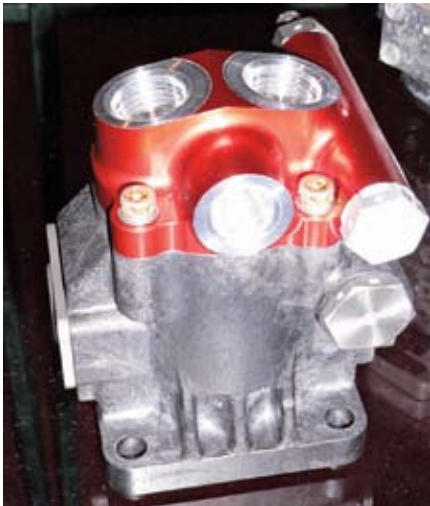


Edited by **Ryan Gehm**

Materials in motorsports

Around 120 racing experts gathered in Cologne, Germany, at the Global Motorsports Congress to discuss recent developments, challenges, and opportunities impacting not only the motorsports realm, but also the production-car world. Among many technical areas of interest, including powertrain (see Performance & Aftermarket for more coverage), industry insiders at the November event discussed the importance of optimizing materials to improve overall vehicle performance.



Parker Hannifin is testing a new hydraulic pump with a PEEK (polyetheretherketon, a semi-crystalline, high-temperature engineering thermoplastic) polymer housing as a way to bring down the component weight for use in Formula One racing.



At the Global Motorsports Congress, Hans-Michael Guether of SGL Brakes explained details of material and design aspects when it comes to optimizing carbon/carbon and carbon/carbon fiber-ceramic composite brakes and clutches.

Gunter Hartmann of **Parker Hannifin** (Abex) presented an example of how aerospace know-how in the hydraulics field can benefit **Formula One** (F1). Unlike **NASCAR** vehicles that have no hydraulics, F1 cannot do without it. According to Hartmann, 10 out of 11 F1 teams use Parker Hannifin hydraulic pumps for their racecars. These pumps are automatically regulated to the required flow via a tilting hanger (also known as a swash plate). The company is testing hydraulic pumps with hyper eutectic aluminum barrels instead of brass to take out two-thirds of the barrel weight.

Another path to bring down the component weight is a new pump with a PEEK (polyetheretherketon, a semi-crystalline, high-temperature engineering thermoplastic) polymer housing that is also being tested at the moment. Presently, these innovations are driven by the needs of the aerospace industry, but "once the aluminum barrel pumps are ripe for the aerospace market, the F1 will be interested as well," said Hartmann.

Computing is a potential bottleneck for racecar and automotive design and/or material optimization through CAx techniques, said Herbert Cornelius of **Intel**. To simulate feasibility and applicability under extreme conditions, more computing will be needed, he is convinced.

"Today we are working with teraflop machines [1012 floating point operations per second], but we are moving on to petaflops [1015 flops] so there will be plenty of computing power available," Cornelius said. "Supercomputing is being democratized. The price per 109 flops has come down." This power can be used to simulate fluid dynamics for whole cars instead of subsystems, he suggested. More power will also allow increased model sizes and very short reaction times.

CRP Technology's Franco Cevolini gave an example of how the company uses laser sintering to improve components and their material makeup. The new Windform material, for instance, consists of aluminum and glass fiber. It has a very low density, high melting point, and high tensile modulus. Using this material for the air box and front fender of a 250-cc racing bike, CRP claims to have given the bike up to 9.5% more power through an improved airflow.

"No F1 car or road car would be possible without adhesive bonding," stated Josef Oberski of **Henkel's** Teroson brand. His speech focused on the exceptional demands on design and material in F1. Oberski introduced show-goers to the basic chemistry of adhesive bonding and explained future trends, such as the



Diamond-like carbon coatings by Bekaert can help reduce fuel consumption and emissions by 1 to 2% by reducing friction in engine components.

growing need to bond different kinds of materials with more and more polyolefins.

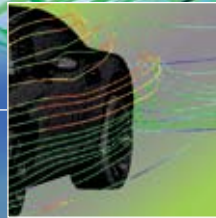
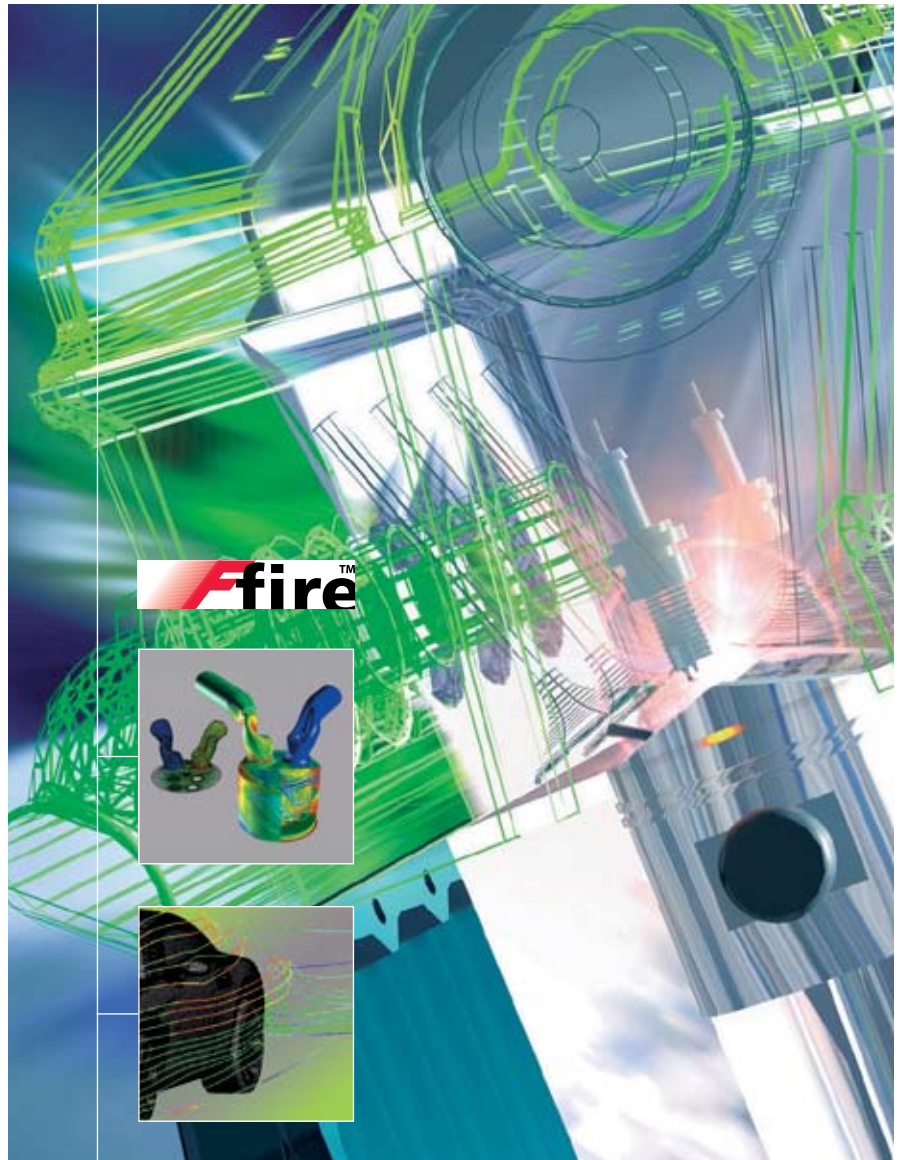
"New nanocomposites will also mean new demands on adhesive bonding," Oberski said, "as these materials can be tailor-made to the application. However, that means they will also require special bonding."

Frits Altorf presented **Koni's** frequency selective damping (FSD) technology. Originally developed for the aftermarket, this system offers lower damping force at high frequencies (for improved suspension control) and high damping force at low frequencies (for improved body control). He finished by saying that his company will announce soon which F1 racing team will begin to use FSD.

As coatings can have a great influence on friction losses, another speaker had been invited to talk about tribology. "To bring down wear, the combination of optimized surface treatment and coating is important," said Mark Boghe of **Bekaert** Advanced Coatings. "Except for the long maintenance intervals and the cost angle, the needs of the automotive and F1 industries are mostly identical."

On the background of a greater than 50% market share of Cavidur racing coatings, Boghe stated that a suitable coating can bring down the power needed to drive valve actuation by around 30%. Asked for the total efficiency gain in terms of fuel consumption, he estimated that it could be lowered by 1 to 2% overall through the use of coatings.

Joerg Christoffel

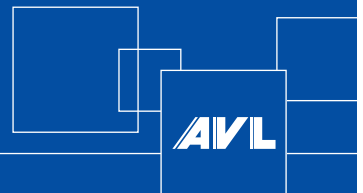


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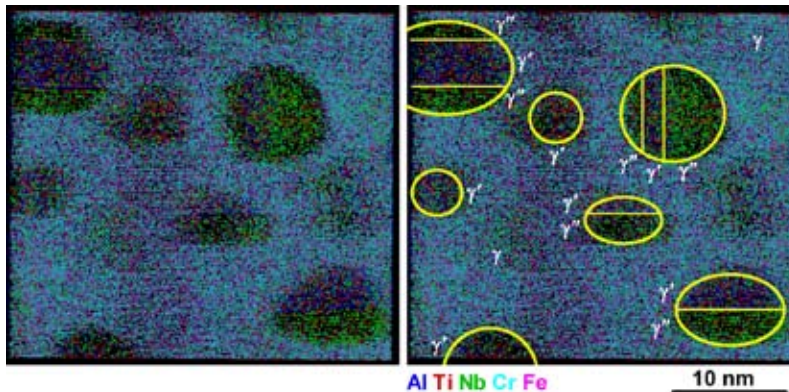
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CONNECTING EXPERIENCE

Ford pursues light weight via nanotechnology

Via its collaborative research activities with **Northwestern University** and **Boeing**, **Ford** is using "one of the most advanced laboratory devices in North America" to accelerate its nanotechnology research into lighter weight, yet stronger, metals and plastics. Ford hopes these materials ultimately will be used in parts that help improve the safety and fuel economy of its cars and trucks.

The device, called the Local Electrode Atom Probe (LEAP), is manufactured by **Imago Scientific Instruments** and housed at Northwestern University.



The LEAP 3000X atom-probe microscope is suitable for materials characterization at the nano scale, making it useful for nano-structure analysis in advanced materials research. Shown is an atom map of complex precipitates in nickel-based Alloy 718 (specimen provided by Oak Ridge National Laboratory).



An Imago LEAP 3000X microscope (similar to this one) located at Northwestern University enables Ford to cut in half the amount of time it takes to analyze the molecular makeup of metals and plastics and determine ways to tailor the material to make lighter, more durable parts.

According to Ford, it is now one of only four such tools in North America. The LEAP 3000X microscope enables Ford to cut in half the amount of time it takes to analyze the molecular makeup of metals and plastics and determine ways to tailor the material.

As with traditional atom-probe tomographic (APT) microscopes, the LEAP microscope achieves true 3-D atomic-scale analysis by using a high electric field to remove individual atoms from material surfaces and a position-sensitive detector to record information that reveals the atom's position and identity. However, the incorporation of a local electrode eliminates or mitigates many of the performance limitations of traditional APTs, according to the Northwestern University Center for Atom-Probe Tomography. The Imago LEAP microscope also analyzes significantly larger volumes—typically 50 x 50 x 100 nm (2.0 x 2.0 x 3.9 μm)—in less time (hours vs. weeks or months).

Last summer, Imago installed its LEAP Laser Pulse module at Northwestern University, which provides the LEAP 3000X microscope with the capability for analysis of semiconductor and other high electrical resistance specimens. "The laser enhancement will enable us to study more readily metallic, semiconducting, and oxide materials, as well as branching out into organic materials," said Professor David Seidman of Northwestern University. "We are able to switch from electrical to laser pulsing with literally the push of a button."

Imago has installed its LEAP Laser Pulse module at Northwestern University. "The laser enhancement will enable us to study more readily metallic, semiconducting, and oxide materials, as well as branching out into organic materials," said Professor David Seidman, standing next to Northwestern's LEAP microscope pre-upgrade.



Stephen Anzaldi

At Northwestern, Ford researchers are working with nanotechnology—the science of manipulating materials at the atomic or molecular level—to develop structural materials that use nanoparticles as fillers to reduce weight and increase strength. For example, researchers are making aluminum castings for engine blocks that are reportedly stronger and better-performing. Paints and glass that block the sun’s IR radiation and clean themselves of dirt and grime also are being researched.

An additional area of focus for Ford is developing nanofluids, which involves dispersing nanoscale particles into vehicle liquids, such as coolants, engine oil, lubricants, and transmission fluids. Ford scientists found that sprinkling nanoparticles into these liquids reduces friction and increases thermal conductivity, allowing the liquid to operate at lower temperatures.

“Since nanotechnology can impact such a wide range of vehicle components and functionalities, it provides a versatile toolkit for meeting anticipated customer expectations for performance, comfort, convenience, and quality,” said Erica Perry Murray, on-campus Ford-Boeing-Northwestern alliance manager.

The alliance between Ford, Boeing, and Northwestern, announced in late 2005, paves the way for the three to research commercial applications of nanotechnology, potentially leading to future advancements in transportation, specialty metals, thermal materials, coatings, and sensors. Ford and Boeing have been working together on technology development for more than a decade.

Examples of past technology sharing between Ford and Boeing include human factors modeling and aluminum bonding. For the prior, Ford shared with Boeing its “Third Age Suit,” which is made of materials that add bulk, restrict movement, and obscure vision to help give engineers and designers a feel for the needs of the elderly. By using the suit, Ford and Boeing engineers have been able to research ways to provide more user-friendly interiors for cars and aircraft.

Boeing shared with Ford its expertise in aluminum bonding from aerospace products for production of the Ford GT super car. The technology, including the use of friction stir welding, was used by Ford to bond the center tunnel of the

Ford GT to its floor pan without deformation.

“Ford has a long history of research in the field of nanotechnology,” said Gerhard Schmidt, Ford’s Vice President of Research and Advanced Engineering. The automaker has been active since the

1970s in exhaust catalysis and emission controls, which are nano-based systems. Catalysts use nanoscale precious metals to increase the surface area of the metal, reducing costs and making them more efficient.

Ryan Gehm



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