WARDSAUTO™

THE BIG STORY / NOVEMBER 2016

Lightweighting INNOVATIONS

UNSUNG HEROES OF THE WEIGHT-LOSS BATTLE. • BY DREW WINTER

IN 1977, FORD ROLLED OUT a car with a carbon-fiber body that weighed just 2,500 lbs. (1,334 kg). It wasn't a sports car, but a 4-door Galaxie family sedan that was 1,250 lbs. (567 kg) lighter than the automaker's upcoming '79 production model. Ford promised then that it could make huge strides in weight and fuel economy with carbon fiber when it became less expensive.

Almost 40 years later Ford rolled out a production carbon fiber-intensive Ford GT. It's exotic and glamorous and weighs 2,890 lbs. (1,311 kg). It also has a price tag of $400,000.

Since the earliest days of the automobile, engineers have liked making big plays with materials. As time goes on, their dreams just seem to get bigger.

General Motors launched fleets of plastic-bodied minivans and Saturns in the 1990s; Audi and Jaguar Land Rover have made big splashes with all-aluminum vehicles. Ford arguably has made the biggest materials transition ever with the introduction of the aluminum-bodied F-150 pickup in 2014.

Sometimes these moves are successful and impress car buyers and Wall Street. Other times they are duds.

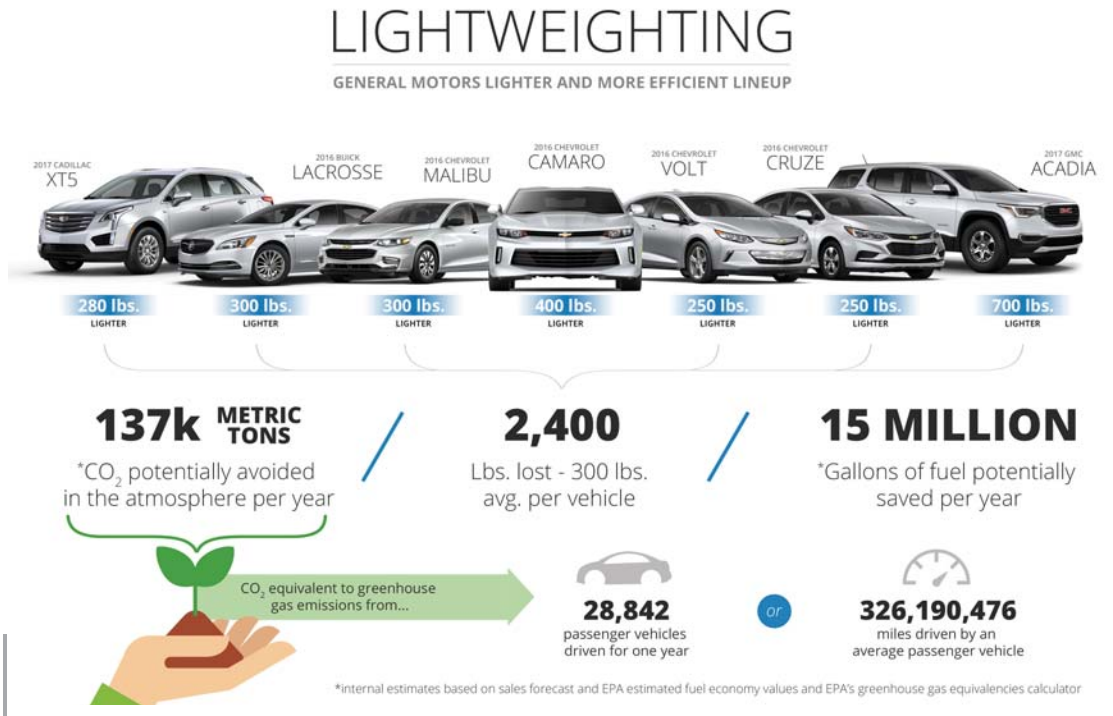
Gorilla Glass used on Ford GT 37% thinner than conventional auto glazing. If used on all openings of typical passenger car it could reduce weight 27 lbs. (12.2 kg).

But there is a lot more to vehicle lightweighting than epic battles between steel, aluminum and carbon fiber for the keys to the body-in-white castle. Every nut and bolt is scrutinized for weight savings and so is every door seal, scrap of leather and piece of sound insulation. As vehicles get lighter there are unsung heroes hidden in every nook and cranny.

"Anywhere there is a benefit of a 5% weight reduction (OEMs and suppliers) will get excited," says Dirk Zinkweg, global strategic marketing manager-Transportation, Dow Elastomers. The company is a raw-material supplier several steps back in the supply chain, but it plays a major role in lightweighting.

About 85 lbs. (39 kg) of polypropylene plastic is in a typical vehicle, used for everything from bumpers to instrument-panel parts. Dow Elastomers works with compounders, companies that mix up batches of plastics that offer special performance characteristics.

The compounders use Dow Elastomer's chemical components to create polypropylene alloys and composites with characteristics that enable molders to make parts that are lighter because they are stronger and thinner, less dense or foamy. Parts like these, added together, are having a huge impact on the future of the auto industry.



RÖCHLING
Automotive

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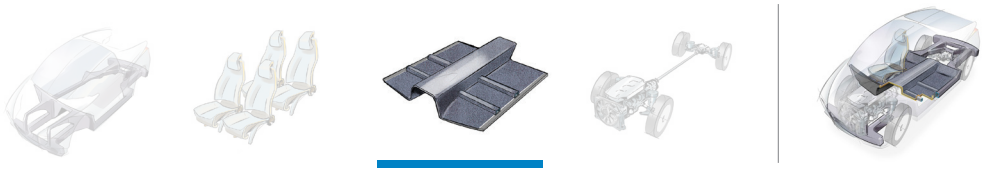

Lighter weight solutions, integrated from the floor up.

We're lightening the load for OEMs across the globe with lightweight and acoustically superior structural components and modules. Our integrated sandwich floor (ISF) utilizes its functional multi-layered construction to integrate the single layers of traditional carpeting, acoustic material, metal car body, and underbody panels. The result is a solution that not only provides significant weight reduction but also delivers improved acoustic and thermal comfort.

Little Things Add Up

General Motors brags that seven of its latest models are 250 lbs. (114 kg) to 700 lbs. (318 kg) lighter, potentially saving 15 million gallons (57 million L) of fuel a year.

The GMC Acadia lost a lot of its 700 lbs. through downsizing, but the rest of the weight mostly was shaved off with a scalpel, using slightly thinner-but-stronger advanced high-strength steel alloys, scalloping out unnecessary bits of metal here and there and using sophisticated adhesives in place of welds and rivets. There is not a lot of materials drama.

The advanced-steel grades are only thinner by the width of a human hair, but "it's all the little things that add up to the big number," Charlie Klein, executive director-General Motors Global Carbon-Emissions Reduction Strategy, tells *The New York Times*.

Suppliers that can help a car or truck lose just a pound or two get plenty of attention from automakers and can reap big rewards.

GST/Seton AutoLeather has developed a breakthrough re-tanning chemistry and process that enables it to offer a product called LWL that is 15% to 20% lighter than conventional automotive leather.

This weight savings translates into 2.0 lbs. to 2.5 lbs. (0.9-1.1 kg) per vehicle and has sparked a lot of interest, says Senior Vice President Stephen Jeske. There is

GMC Acadia lost a lot of its 700 lbs. through downsizing, but rest of weight mostly shaved off with scalpel.

no thickness reduction or change in product characteristics, he adds.

Another promising area for taking out weight is the vehicle greenhouse. Automakers and suppliers have been working for years on plastic windows for vehicles with only limited success. One of the key issues is clear polycarbonate plastic simply does not damp sound like automotive glass and creates a noisy cabin environment.

The Ford GT offers a solution not seen before by using Corning's Gorilla Glass, the same stuff used for smartphones, for the windshield and rear glass.

The Gorilla Glass used on the Ford GT is 37% thinner than conventional auto glazing, and if used on all openings of a typical passenger car it could reduce weight by 27 lbs. (12.2 kg) proponents say.

Like standard automotive glass, it actually is a glass laminate that sandwiches an inner layer of PVB plastic, but it is manufactured differently. In addition to being light and strong, Gorilla Glass also has great optical properties for head-up displays. Unfortunately engineers say the manufacturing process currently is too expensive for Gorilla Glass to be used on mainstream vehicles anytime soon.

GST/Seton AutoLeather's Jeske shows off LWL lightweight leather.

IAC's injection-molded dash inner provides estimated 40% weight reduction compared with conventional product.

Lightweight Sound Insulation

There is significant progress being made in the area of acoustics as well. Unfortunately, while automakers are being pressed to reduce weight on all fronts to minimize carbon-dioxide emissions and improve fuel economy, consumers are demanding quieter and quieter vehicles. That requires automakers to add a variety of sound-deadening materials that add weight.

That has auto-interiors suppliers such as IAC working overtime on new ways to control noise. Last summer it announced it was producing a new lightweight injection-molded inner dash insulation part for superior interior acoustical performance at a new facility in Prestice, Czech Republic. The factory already is making products for two premium European automakers and it will be starting a major door trim program soon.

The injection-molded dash inner provides an estimated 40% weight reduction compared with a conventional product, IAC says.

Traditionally, these types of acoustic parts are made in a vacuum-forming process where a heavy thermoplastic-based sheet is molded in a tool under vacuum. The process has limitations because the thickness of the part is nearly uniform. Detailed and precise part geometry is difficult to fabricate.

IAC's injection-molding process is able to create parts that are thicker and heavier where more insulation is needed and thinner in other areas. "By doing this, IAC can optimize the acoustic performance and at the same time reduce the weight of the component," a spokesman says.

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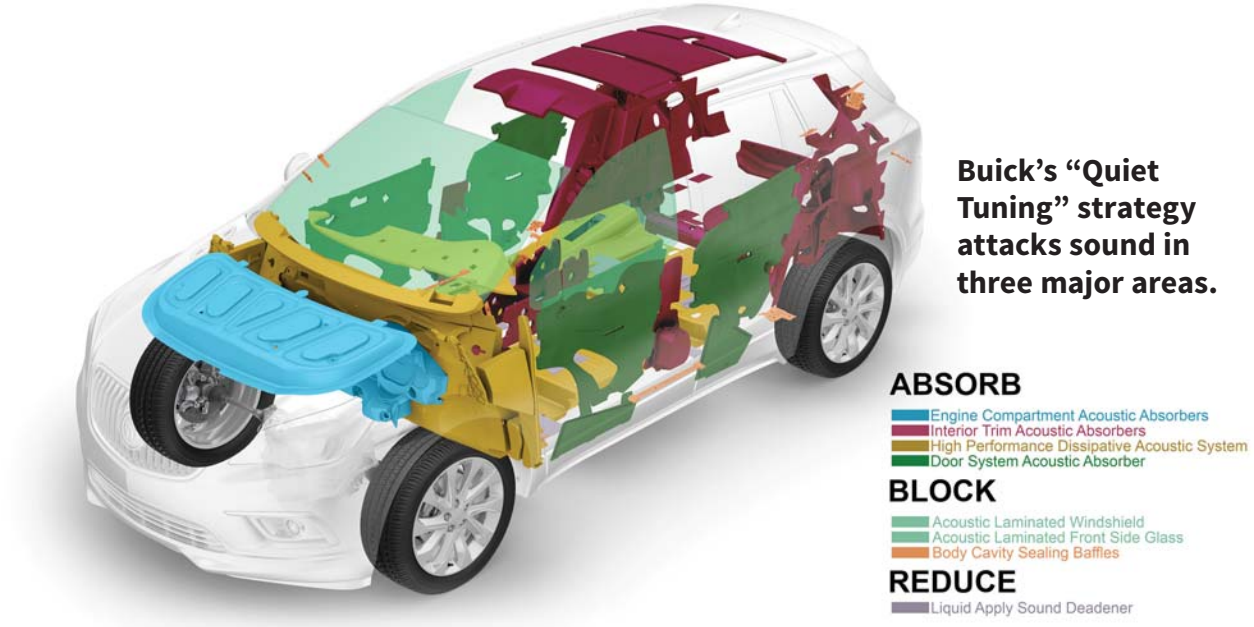
Also improving acoustic properties is the exact and reliable material distribution offered by the molding process so a component can be designed and produced to perfectly fit the dashboard.



Buick's "Quiet Tuning" strategy attacks sound in three major areas.

Sandwich Anyone?

In a similar vein, supplier Röchling Automotive is touting what it says is the first integrated sandwich vehicle floor. The sandwich concept features layers of lightweight reinforced thermoplastic materials and aluminum, plus some integrated beams.

The sandwich material combines sound-deadening and thermal insulation with mechanical properties that meet all requirements regarding stiffness and crash energy absorption.

The fullsize modules can replace the weight- and cost-intensive redundancies of common floor systems and save automakers up to 33 lbs. (15 kg), the supplier says. Metal shear fields and acoustic layers are replaced by the new sandwich structure that offers high variability to adjust properties according to needs.

A weight advantage of 50% relative to steel plate is achievable, a spokesperson says. Along with the possibility of creating strong and light components with this material, the excellent acoustic absorption characteristics of the non-woven textile-based layer offers another advantage: very low drive noise, which has particular importance for electric vehicles, the spokesperson says.

The integrated sandwich floor components are produced in a one-shot molding process and accelerate the evolution of thermoplastic composites in automotive engineering, Röchling says, and the ability to preassemble added components also offers new opportunities for future vehicle production and design.

SANDWICH CONCEPT

An integrated sandwich vehicle floor features:

- layers of lightweight reinforced thermoplastic materials and aluminum
- sound-deadening and thermal insulation
- mechanical properties that meet all requirements regarding stiffness and crash energy absorption

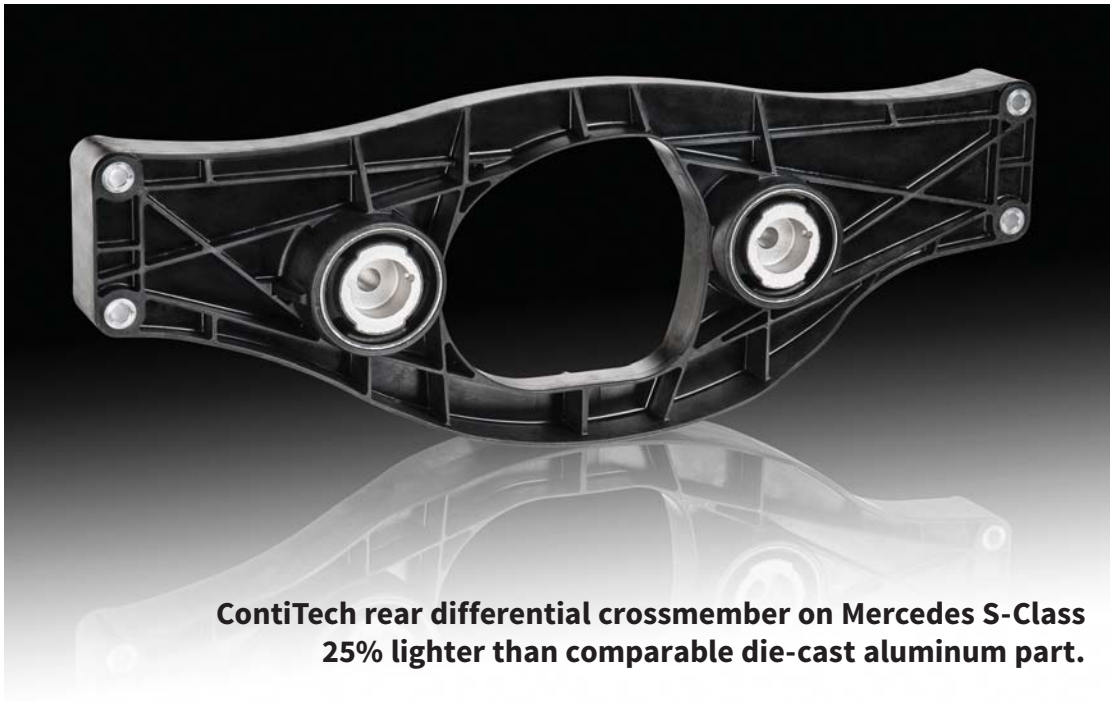
Plastics Innovation Continues

In recent years, media attention has focused on aluminum and carbon-fiber-reinforced composites, but more conventional plastics and glass-fiber-reinforced composites are continuing to break down barriers.

It wasn't long ago the idea of bolting a plastic intake manifold to an engine block was unthinkable because everyone thought it would melt. Now plastic intake manifolds dominate the marketplace and plastics are making conquests in key structural areas.

One of the newest breakthroughs is the rear differential cross member on the '16 Mercedes-Benz S-Class. The beefy structural part typically is made of aluminum or cast iron.

For the first time, Mercedes is using a rear crossmember made of an injection-molded glass-fiber-reinforced polyamide plastic supplied by BASF and fabricated by ContiTech. It is 25% lighter than a comparable die-cast aluminum part, but it also has better damping properties than the aluminum version and reduces noise transmitted from the driveshaft.



ContiTech rear differential crossmember on Mercedes S-Class 25% lighter than comparable die-cast aluminum part.

In another impressive example, GM lopped 20 lbs. (9 kg) from the ’16 Corvette using new lower-density plastic body panels, a huge achievement considering Corvette engineers will pop a bottle of champagne after saving just a few grams here and there.

The weight savings was achieved with the first production use of Continental Structural Plastics’ TCA Ultra Lite advanced composite material, which uses small glass bubbles to replace some of the calcium carbonate filler material traditionally used in Corvette panels, resulting in lower-density parts. The Ultra Lite material was introduced as a running change on the C7 Corvette on 21 body panel assemblies, including doors, decklids, quarter panels and fenders.

“In materials engineering, shaving a single pound per car is a significant accomplishment, so saving 20 lbs. per car is monumental,” says Tadge Juechter, Corvette chief engineer.

“This is a great example of how Chevrolet is continually looking for innovations that improve performance on Corvette and could benefit possible future applications.”

Importantly, the lightweight composite also offers a premium Class A finish with paint and gloss qualities comparable to metals, including aluminum. It also is able to withstand the hot E-coat prepaint process and all OEM paint tests, which simplifies manufacturing and assembly operations.

The 2016 Corvette Z06 C7.R Edition


Ford F-250

Finding Lower-Cost Solutions

You might think engineers working on the hulking ’17 F-250 pickup stopped worrying about weight now that the giant has shifted to aluminum-intensive construction like its little brother, the F-150, but you would be wrong.

They also are very concerned about cost. That has led them to another plastic innovation, a composite seat-cushion frame, the first time a plastic composite has replaced a magnesium part in this type of application.

Traditionally steel is the material of choice in seat frames, but rising fuel-economy standards have pushed automakers into aluminum and even lighter magnesium components. But Ford engineers say there are a lot of cost issues with the magnesium cushion frame. The tooling requires constant maintenance, secondary manufacturing operations are required along with special fasteners and the material itself is very expensive compared with composite plastics. Plus magnesium parts have a bigger carbon footprint.

That led engineers to develop a new structural cushion frame and under-seat storage lid to replace the existing cast-magnesium frame. The challenge was to create a part that would perform well in a seating application that is crucial to crash safety.

Starting with a 40% long-fiber glass-filled polypropylene from Celanese, Ford engineers developed a new computer-aided engineering methodology to interpret and predict the dynamic performance of composite structures in crashes.

The result is an industry first where Ford was able to replace an expensive magnesium part with a weight-neutral and more environmentally friendly composite plastic structural cushion frame, an accomplishment that made it a winner in the 2016 Society of Plastics Engineers Innovation Awards.

Future of Automotive Materials Not Predetermined

To some, the automotive materials path looks like mankind's prehistory, steadily progressing from steel and aluminum to magnesium and carbon fiber like man evolved from the stone to bronze and iron ages.

But as the steel folks are quick to point out, all the lightest materials require a lot of energy to manufacture and have big carbon footprints unless that energy comes from renewable sources such as hydroelectric power. They also pose joining and welding challenges and remain stubbornly more expensive than steel.

Even so, according to the Ducker Worldwide "2015 North American Light Vehicle Aluminum Content Study," within the next decade aluminum sheet for light-vehicle body and closure parts will grow from less than 200 million lbs. (91 million kg) in 2012 to nearly 4 billion lbs. (1.8 billion kg). Within the same timeframe, every leading automaker is expected to have an aluminum body program in place, according to the study.

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While more aluminum-intensive vehicles certainly are in the cards, industry sources say the majority of future vehicles likely will use a mixture of materials that will take advantage of the specific strengths of individual materials while minimizing overall costs. While this presents additional joining and welding challenges, automakers and suppliers are well on their way to solving these issues.

New Joining, Welding Technologies Arriving

STANLEY Engineered Fastening, a major global supplier of what it calls engineered fastening technologies, has announced it is adding to its portfolio of what it calls "holistic lightweighting systems" to meet upcoming materials challenges. In addition to conventional stud-welding systems and plastic fasteners, the company is bringing its next-generation self-pierce rivets to the North American market for the first time.

SEF says its technologies can solve burgeoning lightweighting challenges, including the assembly of aluminum body panels, which it says can't be joined by traditional welding techniques. Demand for self-pierce rivets, which already are used extensively in Europe by automakers such as JLR, is on the rise in North America as automakers increasingly adopt materials such as aluminum.

SEF says it is working with several major North American automakers interested in SPRs to help integrate lightweight alternative materials, such as aluminum and carbon fiber, into their vehicle platforms.

STANLEY Engineered Fastening self-pierce rivets used to join pieces of Range Rover B-pillar.

"Whether joining aluminum, steel, plastics, composites, or combinations of materials, SPR is ideal for joining sheet materials providing a watertight joint," says Siva Ramasamy, vice president-Breakthrough Innovation. "SPRs are installed with a servo-driven

tool enabling control of the rivet-setting process for uncompromised repeatability. The system provides process-monitoring capabilities, enabling increased productivity and quality."

GM also announced earlier this year it has developed a new welding technology for joining dissimilar materials.

The automaker developed the process in-house and says it solves the problem of joining the two disparate metals through spot welding, a hurdle due in large part to the widely different melting points of aluminum and steel.

GM announced earlier it would begin using the process this year in production of the Cadillac CT6 sedan at its Hamtramck, MI, assembly plant, where the technology first will be employed for seatback construction, followed closely by hoods.

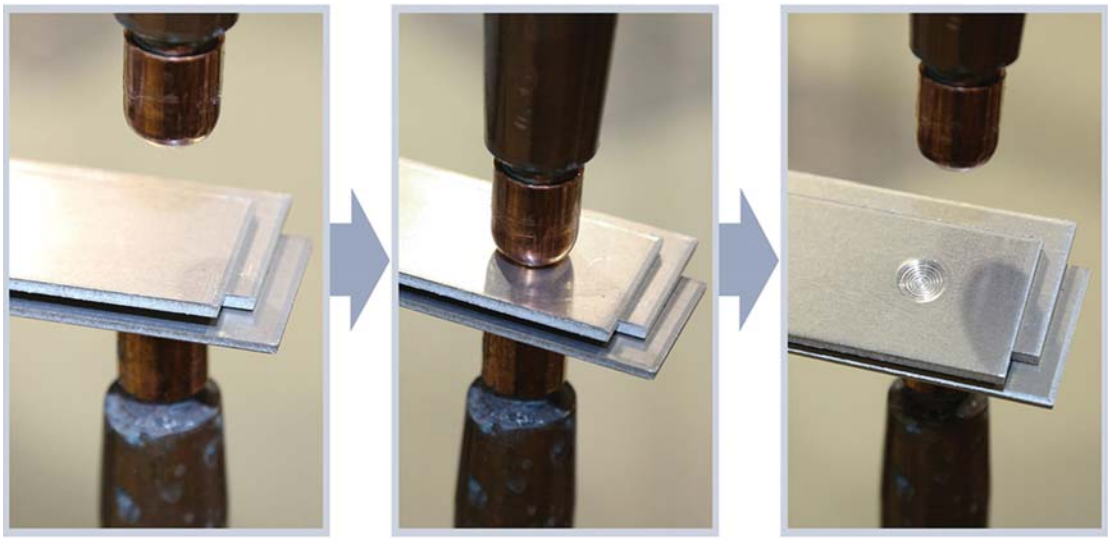
The aluminum-to-steel spot-welding system makes use of a uniquely designed welding tip patented by GM. However, the tip fits with conventional tooling, so there is no need for specialized welding equipment. GM is expected to make the process available to other automakers interested in licensing the technology.

The process is the next step in the manufacturing evolution

Cadillac CT6

WELDING PROCESS MAY HELP IMPROVE FUEL ECONOMY

GM's new resistance spot welding process, using a proprietary multi-ring domed electrode, will enable more use of lightweight aluminum, which can help boost fuel economy.



that saw aluminum-to-aluminum welding capability, introduced around 2008, reach widespread application in today's factories. GM is hoping it can exceed the pace of that 8-year ramp-up when it comes to proliferating the aluminum-to-steel welding technology.

The automaker says the welding process allows it to eliminate rivets used to join aluminum and steel body parts, cutting costs and mass. With aluminum-to-aluminum welding, cost savings in rivets alone are estimated at $5-$100 per vehicle, depending on the number used, with weight savings of 0.7-11 lbs. (0.3-5 kg) per vehicle. Manufacturing costs also are lower, the automaker says.

In the initial aluminum-to-steel program for seatbacks, GM will move cautiously, replacing a couple of the rivets currently used with the advanced spot welds to test the manufacturing process and prove part durability before moving on to more extensive applications.

Will Carbon Fiber Ever Become Mainstream?

Even though carbon-fiber-intensive vehicles will remain at the exotic level for the foreseeable future, use of carbon-fiber parts continues to grow. BMW makes extensive use of the material in the body structures of its i3 and i8 cars as well as the latest 7-Series, but cost prevented similar use in its new 5-Series.

There also is a lot of work being done in the development of carbon-fiber wheels for performance cars.

And many high-performance cars have carbon-fiber hoods, spoilers and structural parts. Plus the new Toyota Prius Prime plug-in hybrid has a big, gorgeous carbon-fiber hatch. The material's great strength and light weight makes it powerfully seductive despite its high cost and fabricating challenges.

"We're working with every major OEM in the world. The amount of development going on is tremendous," says Andrew Swikoski, global product line director-Composites, at giant auto-supplier Magna. Asked about relative interest by region, he says "There's a

BMW i3

Toyota Prius Prime PHEV carbon-fiber hatch. Material's great strength and light weight powerfully seductive despite high cost and fabricating challenges.

big pull from Europe and North America," and adds interest is strong in China in connection with the electrification movement.

Magna currently supplies the hood for the Cadillac CTS-V and ATS-V and the grille opening reinforcement on the Mustang.

He says Magna is working to cut costs and has made a lot of headway in terms of taking cost out of the production process "and we're continuing to work on the material side."

However, most of the near-term opportunities are in cosmetic components as opposed to structural parts. The structural parts take more time to validate with the customer, he says, "but the opportunity is bigger." **WA**

DREW WINTER *is a senior editor at WardsAuto.com and also oversees the editorial content and agendas for the annual WardsAuto Interiors and User-Experience Conferences. He has been writing about automotive materials for more than 30 years.*