



# International Magnesium Association

## Mg Showcase

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### *Magnesium in Motion*

The automotive industry's future is riding on innovation, and magnesium is sure to be one of the key materials in achieving a new era of lighter, more efficient vehicles. Light metals such as magnesium are often the springboard for technical advances needed to achieve new goals, including fuel/energy efficiency, and reducing carbon dioxide (CO<sub>2</sub>) emissions.

Magnesium applications in the transportation sector abound, with many in development. This lightest of all structural metals promises to play an integral part in designing and manufacturing more competitive vehicles that flourish in global transportation markets.

#### **Survival of the Lightest**

Lightweighting has become more than a trend – it is the blueprint for an entire industry whose future depends on light metals, in particular magnesium, for survival. With fuel economy and CO<sub>2</sub> emission regulation the predominant driving forces for change, components are now designed to radically reduce vehicle weights across the board without sacrificing structural strength.

Highly recyclable magnesium is currently used for a number of car and light truck vehicle components including: ultra lightweight car engines; engine valve covers; instrument panels; steering components; radiator supports; door and liftgate inners; seat structures; and wheels in a furious flow of new development. Never before has the transportation industry seen a more intense push to evolve and innovate in order to compete and survive.

The Canadian government's Lightweight Materials Innovation Strategy, based on consultations with industry experts and the Canadian government, emphasizes vehicle lightweighting to reduce air pollutants and greenhouse gas emissions, and create better performing and riding vehicles. The strategy maintains that reducing vehicle weight is the most cost-effective way to cut CO<sub>2</sub> emissions and lower energy consumption in the transportation industry. Their estimates show that for every 10 percent reduction in vehicle weight, 6 to 8 percent fuel efficiency is gained, and a corresponding reduction of about 17 to 20 kilograms (kg) of CO<sub>2</sub> emissions per kg of weight reduction over a vehicle's lifetime.

#### **Magnesium's Strength Supports Innovation**

Meridian Lightweight Technologies, Inc., of Strathroy, Ontario, Canada, supplies automakers with magnesium components. In the light truck category, Meridian supplies the die-cast magnesium front-end structure for the Ford F-150, using magnesium alloy AM60B, which is powder-coat painted

black. The magnesium support structure provides torsional stiffness to the front end. This key component provides attachment areas for the hood latch, radiator, horn, front fascia, head lamps, hood seal, wireless harness fuse box, power steering reservoir, and air-conditioning condenser.

Aaron Klop, Product Development Engineer at Ford notes that the F-150 front structure bolster/radiator support component is a die-cast magnesium part that has secondary pierce and coating processes applied. "Magnesium was chosen because of its high strength and lightweight material properties," Klop said, "The material, along with the manufacturing process, enable the part engineer to design a single, complex part that integrates many attachment features that would require multiple parts if other materials and processes were used."

#### **Smart Design Relies on Magnesium**

Meridian's Business Development Manager, David R. Greer, Jr., says that magnesium is one of the best choices available for vehicle lightweighting. According to Greer, magnesium offers the best solution for fuel cells, hybrids, and internal combustion engines, which all use castings: "Magnesium improves fuel economy by reducing powertrain mass in replacing aluminum, regardless of powertrain type. Tooling savings related to use of magnesium body panels provide original equipment manufacturers (OEMs) with weight savings and an investment cost advantage, and provides panel shapes that cannot be done with traditional stamping methods."

Greer says that research into magnesium applications bodes well for vehicle manufacturers. "Future vehicles are poised to make significant inroads, once automakers focus on innovating with light metals. Automakers are looking to magnesium to reduce mass without incurring the cost impact of high-strength steels or fiber reinforced plastics."

According to U.S. Department of Energy's Advanced Lightweight Materials for Automotive report exploring government-supported automotive lightweighting efforts in North America [U.S. DOE, 2008, Office of Energy Efficiency & Renewable Energy], magnesium alloy applications in the automotive industry receive the second highest funding level among automotive materials researched by national labs, universities and industry.

Toyota's new Venza crossover model uses a magnesium engine valve cover. The 2009 Venza uses die-cast AZ91E magnesium alloy manufactured by Aisin Japan for the lightweight valve cover component. Tom Nowak, Engineering Design Powertrain at Toyota Motor Engineering & Manufacturing, N.A., notes that Toyota has used magnesium head covers for more than 10 years, and lighter weight is the reason.

In the fuel cell vehicle category, Meridian supplies Honda's new FCX Clarity zero-emission hydrogen-powered fuel cell sedan with a magnesium multi-layered instrument panel, featuring 3-D gauges. The as-cast panel also uses magnesium alloy AM60B. This next-generation hydrogen-powered FCX offers a 25-percent increase in combined fuel economy equivalent to 74 miles per gasoline gallon, compared to its previous generation vehicle.

### New Alloy Advances Benefits: Magnesium AM-SC1

The Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia, is working closely with the United States Automotive Materials Partnership (USAMP) on a new low-pressure/sand-cast magnesium engine research project using alloy AM-SC1. USAMP includes Ford, General Motors and Daimler Chrysler. The alloy, developed as a result of an international collaboration organized through the Cooperative Research Centre for Cast Metals Manufacturing (CAST), will be the basis for creating motor vehicles that are lighter, environmentally cleaner, and substantially more fuel efficient. CSIRO researchers tailored the alloy composition to have specific properties required by the engine caster Hydro Aluminium, Norway, and the engine designer AVL, Austria.

CSIRO's research shows that this advanced magnesium alloy not only boasts a higher strength-to-weight ratio, but also offers higher dampening of noise and vibration than either aluminum or steel. The AM-SC1 development team of CSIRO includes the University of Queensland, Brisbane, Australia; Monash University, Melbourne, Victoria, Australia; and Advanced Magnesium Technologies (AMT).

AM-SC1 is formulated for sand/permanent mold casting for engine blocks and transmission housings that require high-strength metal performing at temperatures ranging from 150 – 200°C. Advanced Magnesium Technologies (AMT) of Australia is actively involved in the USCAR Magnesium Powertrain Cast Components (MPCC) program, along with Ford, GM, Chrysler, and the U.S. Department of Energy, helping to develop a lightweight magnesium engine using this new alloy.

Magnesium-intensive V6 engines are being built and tested from the AM-SC1 metal. According to CAST, using this type of magnesium engine block could result in greenhouse gas emission savings of 2.75 tons over a vehicle's life cycle. The researchers' goal has been to develop a magnesium alloy that can withstand high engine temperature extremes, yet retain its strength with reduced weight.

Mike Maj, Research and Advanced Engineering, Manufacturing and Processes Department for Ford Motor Company, says magnesium could become a major factor in achieving these targets. He says such components demonstrate magnesium's potential for dramatic weight reduction, compared to traditional materials. "These magnesium applications demonstrate the potential for system-level savings through parts consolidation, as well as craftsmanship improvements."

The auto industry is ready to overcome past obstacles, allowing design engineers to more widely adopt proven lightweighting applications. Maj notes that magnesium applications are definitely considered for inclusion in future vehicle programs. His research at Ford, and for the USCAR program's "Ultra-Large Casting Project" focuses on new manufacturing processes of semi-solid molding or thixomolding to refine mechanical properties, as well as uncover new approaches to coatings and galvanic isolation that will benefit future magnesium applications for the automotive industry.

(To view the Magnesium Vision 2020 Report, visit: [http://iweb.tms.org/Communities/FTAttachments/MG\\_2020\\_-\\_Released\\_11\\_1\\_11.1.06.pdf](http://iweb.tms.org/Communities/FTAttachments/MG_2020_-_Released_11_1_11.1.06.pdf))

### Magnesium Driving Change

T-Mag™ is CSIRO's new integrated magnesium casting technology that significantly extends the capability and reduces the cost of permanent mold casting for many high-performance components. T-Mag magnesium castings are ideal for high-strength, high-integrity applications, with low tooling and running costs, comparable to permanent mold casting processes for aluminum.

"With T-Mag, you can make a magnesium alloy engine block that is two-thirds the weight of an aluminum alloy engine block," said CSIRO business development manager Sam Tartaglia, "The result is an improved power/weight ratio, increased fuel efficiency and performance, which are much sought-after by premium carmakers."

The advanced casting technology integrates melting and casting operations into a single, compact unit using gravity, rather than high pressure or vacuum to fill the die smoothly from the bottom, resulting in a strong lightweight casting that does not have flow lines or internal porosity. T-Mag saves further on recycling and energy costs by reducing the magnesium needed for this casting process.

To learn more about the benefits of designing products with magnesium, contact the



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1000 N. Rand Road, Suite 214, Wauconda, IL 60084 USA  
Tel. 847.526.2010 • Fax 847.526.3993  
E-mail: [info@intlomag.org](mailto:info@intlomag.org) • [www.intlomag.org](http://www.intlomag.org)

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**IMA: The global voice of the magnesium industry**

#### *Fast Facts:*

- » Die casting with magnesium alloys lets engineers design to specific yield strength, fatigue, and creep criteria.
- » Magnesium parts for transportation weigh a third less than their aluminum counterparts, and are half the weight of the steel parts they replace.