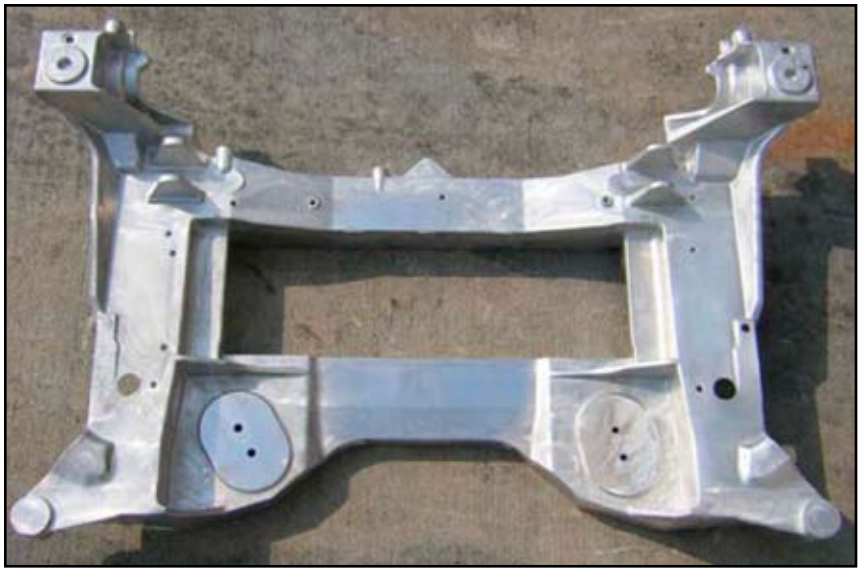
Magnesium Components Achieve Weight Reduction and Fuel Savings

Background

When used for vehicle body components, structural cast magnesium can achieve considerable weight reduction advantages over both steel and aluminum. Furthermore, this favorable weight reduction potential can enable higher fuel economy as well as lower levels of CO_2 emissions. The magnesium industry can be seen as less mature than both the steel and aluminum industries, and there are several technical and manufacturing barriers to the lightweighting application of cast magnesium components. These barriers have prevented significant market penetration of large-scale magnesium body components for automobiles. To date, no U.S. automobile manufacturer produces its own magnesium parts; the few parts that are used originate from a small industry supply base. In partnership with the U.S. Department of Energy (DOE), the United States Council for Automotive Research (USCAR) is supporting research to overcome the technical and manufacturing issues that serve as barriers to the prevalence of large-scale structural applications for cast magnesium components. This work is referred to as the Structural Cast Magnesium Development (SCMD) project.



Z06 Corvette magnesium front crossmember casting (Photo courtesy of GM)

The Technology

The main barriers referred to above are associated with the following:

- a need for casting processes that yield high-integrity, ductile, structural castings that are cost-competitive with aluminum;
- a need to better understand the science of magnesium galvanic and atmospheric corrosion behavior;
- a need to identify commercially viable alloys; and
- a need to improve casting quality assurance and develop component and vehicle level testing.

In finding a solution to the first barrier, the SCMD program identified two casting processes (high pressure die casting and low pressure permanent mold) that achieved the required integrity levels and were cost-competitive with aluminum. High pressure die casting emerged as the favorite, while only a minority of participants continues to advocate low pressure technology. As for corrosion prevention, the team is involved with evaluating various magnesium coating systems and fastener assemblies, as well as conducting stress corrosion cracking susceptibility studies. Furthermore, this work focuses on rigorous tests at the vehicle, subsystem, and component levels that include load

testing, finite element modeling, crash worthiness, and accelerated corrosion tests in the laboratory.

Commercialization

The improved understanding of the material properties of magnesium has resulted in the development of the Corvette Z06 crossmember. While this component continues to undergo demonstrations and testing, the work of the SCMD project has accomplished much in enhancing casting processes and fostering the improved manufacturing processes that will lead to the commercialization of large-scale structural magnesium automotive products.

Benefits

- 65–70% weight reduction compared to steel
- 35% weight reduction compared to aluminum
- Nearly 100 kg (220 lbs) of mass reduction can be achieved in an passenger vehicle when cast magnesium is applied widely to a vehicle

Contacts

Joe Carpenter
Office of FreedomCAR and Vehicle Technologies
(202) 586-1022
joseph.carpenter@ee.doe.gov

Richard Osborne
General Motors Corporation
(586) 575-7039
richard.osborne@gm.com

Philip S. Sklad
Oak Ridge National Laboratory
(865) 574-5069
skladps@ornl.gov

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.