

IMA Award Winners Spotlight Magnesium Innovation

The 2017 IMA Awards of Excellence recognize exceptional achievement in the global advancement of magnesium products and processes, and the IMA Environmental Responsibility Award acknowledges efforts to substantially reduce greenhouse gas emissions and environmental footprint via fundamental changes in process and energy used to power magnesium operations.

An IMA Whitepaper
November 1, 2017

Magnesium Die Cast Side-Door Inner Panel - Part 1

PRODUCT INFORMATION

Name of Part or Process: Magnesium die cast door inner panel

Product Using Part: Prototype door

Function of Part: Provide strength, stiffness, mounting points

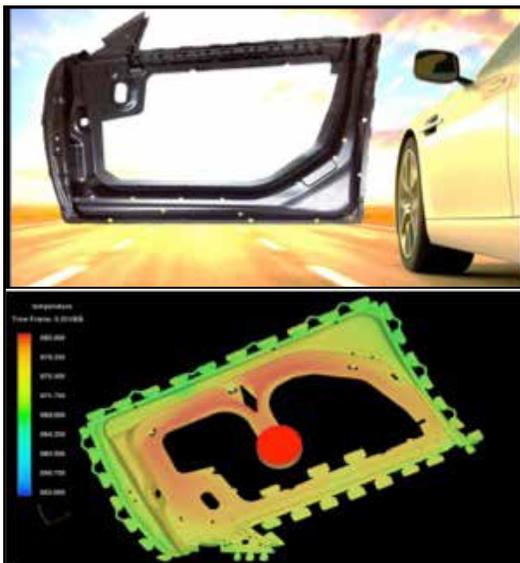
Alloy Used: AM60B

The IMA Award of Excellence winner in the Cast Product Automotive Category is General Motors, Dongguan EONTEC Co., Ltd., and EDAG Engineering, for Part 1 of their magnesium die cast door inner panel. This experimental automotive side-door inner panel was high pressure die cast in magnesium alloy in order to reduce mass, consolidate parts, and enable fine details that cannot be achieved in sheet stampings. Variable wall thickness and extensive use of ribbing were used in order to meet strength and stiffness requirements, while maintaining light weight. Innovative cast-in features include pockets

for attaching the header portion of the door, which surrounds the window glass on three sides, and rivets for attaching a module panel which holds the speaker, window regulator and pull handle. After trimming and machining, the part was coated by micro-arc oxidation and polymer electrocoating to increase corrosion resistance.



Applied-Header Door Panel



Mass: 2.7 kg

Dimensions: 1202 x 843 x 170 mm

Typical wall thickness: 2 mm

Part consolidation:

- Inner beltline reinforcement
- Mirror patch reinforcement
- Hinge mount reinforcement
- Rivets for attaching module panel
- Forward and aft pockets for header attachment

Coatings: micro-arc oxidation plus electrocoat

Magnesium Die Cast Side-Door Inner Panel - Part 2

PRODUCT INFORMATION

Name of Part or Process: Magnesium die cast door inner panel

Product Using Part: Prototype door

Function of Part: Provide strength, stiffness, mounting points

Alloy Used: AM60B

Also, the [IMA Award of Excellence winner in the Cast Product Automotive Category](#) is General Motors, Wanfeng Meridian, The Ohio State University, and EDAG Engineering for Part 2 of this experimental automotive side-door inner panel. In comparison to a conventional steel stamping design, this experimental HPDC magnesium door inner panel design achieves a reduction in mass, reduction in part count, and addition of fine detail features. The mass is only 52% of that of the stamped steel version. And 7 parts are consolidated into 1 casting. The innovative design uses variable wall thickness, ribbing, and an “S”-shaped cross section to achieve the required strength and stiffness. Blind cored holes were cast in for later use with thread-forming screws to attach a stamped aluminum outer beltline reinforcement and a pull handle support. The fully assembled door-in-white includes a stamped

aluminum outer panel, and weighs 9.5 kg, that is about half the weight of the steel counterpart. Advanced modeling and thermal management techniques were used in design of the die in order to achieve fully-filled high-quality castings.

Mass: 52% of stamped steel version

Dimensions: 1209 x 1130 x 290 mm

Minimum wall thickness: 2 mm

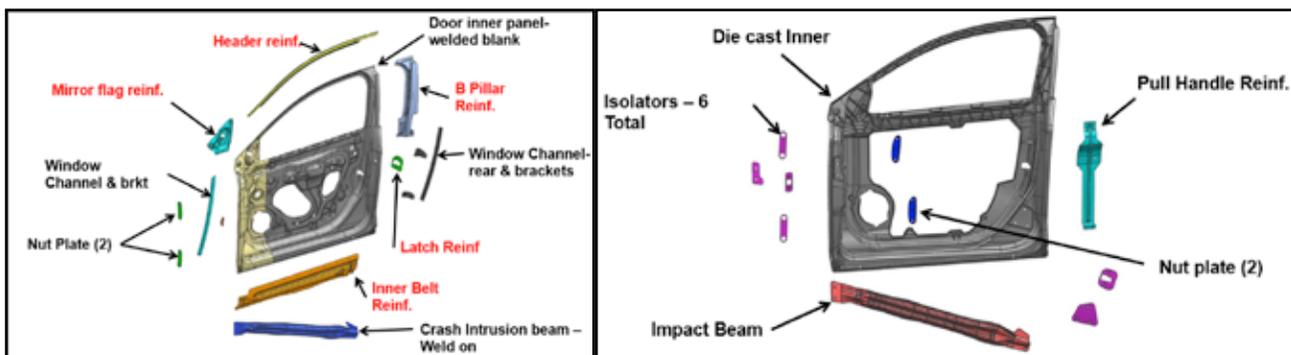
Part consolidation:

- Reinforcements: inner beltline, mirror patch, header, B-pillar, latch mount
- Forward tailor-welded blank

Coatings: conversion coating plus powder coat



Full-Header Door Panel



Steel design - 14 components and 105 welds

Mg casting design - 5 components, 6 isolators and 13 fasteners

Magnesium Wheel for Super-Sport Motorcycle

PRODUCT INFORMATION

Name of Part or Process: Front & rear die cast wheels for super-sport motorcycle

Product Using Part: Mass product YZF-R1 2015 Model

Function of Part: Weight reduction of 870g, improved design & cosmetics

Alloy Used: ASTM-AM60B

The IMA Award of Excellence winner in the Commercial Cast Product Category is Yamaha Motor Company and the Japan Magnesium Association. In 2015, the new model of YZF-R1 was released and included die cast magnesium front and rear wheels. This was a dramatic increase of magnesium usage exceeding 10kg.

1. Application of magnesium in our motorcycle was started in 1998

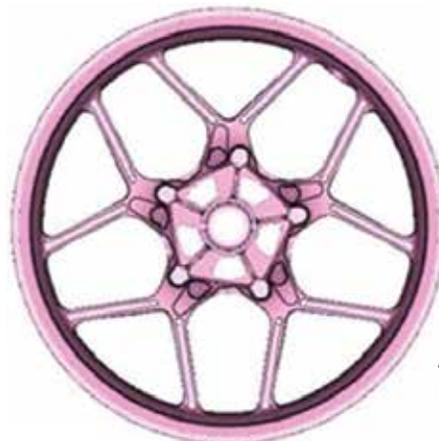
YZF-R1 2015



2. While the use of magnesium for motorcycle parts has been most heavily concentrated in the super-sport or sport categories, there has recently been increased magnesium usage in other power-sport categories.
3. Since 2008, large structural magnesium parts were manufactured in house.
4. Recently, the application of magnesium has been expanded to heat resistant alloy.
5. Magnesium wheels not only result in weight reduction but also decrease inertia mass and improves the design.
6. The Vacuum System process was chosen as appropriate with the part size. With large thin parts, this process was effective in stabilizing the quality of over flow portions.

PREVIOUS

AC4CH-T6
Hollow 5-Spoke



DEVELOP

AM60B-F
H-Type10-Spoke

Biodegradable Magnesium Alloy for Orthopedic Application

PRODUCT INFORMATION

Name of Part or Process: Biodegradable Magnesium Alloy for Orthopedic Application

Product Using Part: RESOMET

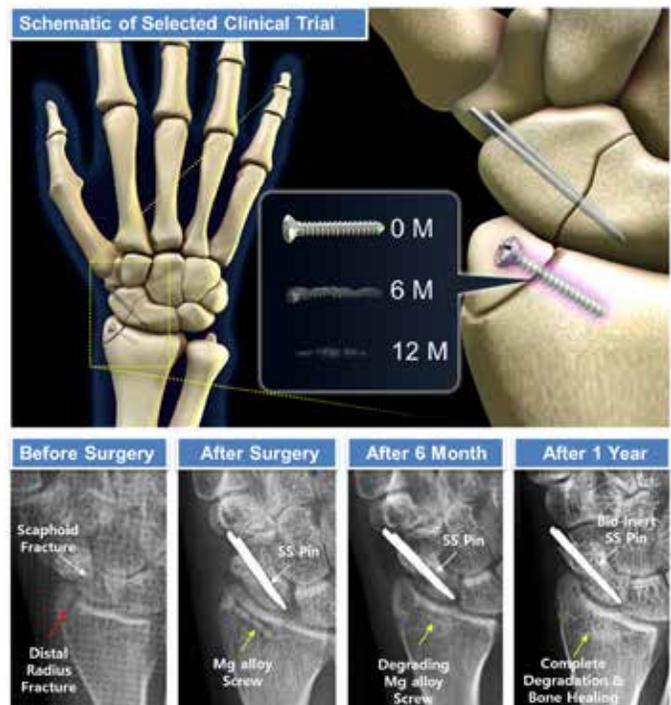
Function of Part: Headless Screw, Cortex Screw and K-wire

Alloy Used: Mg-Ca-Zn Alloy

The IMA Award of Excellence winner in the Process Category is University of Oxford In Collaboration with U & I Corporation. We have overcome the current limitations and created a road map to the next generation of metallic biodegradable implant materials with the addition of completely biocompatible elements. Along with the addition of Ca, which is a biocompatible element that plays major role in bone formation and remodeling, excellent material properties were achieved through the in-house built special mechanical extrusion machine. The state of the art method to synchronize

the corrosion potentials of two constituent phases (Mg + Mg₂Ca) with the selective doping of Zn into Mg₂Ca was developed to control the corrosion rate. Furthermore, mechanical extrusion broke the connectivity of the Mg₂Ca phases, which prevented continuous corrosion and the formation of a galvanic circuit that caused severe corrosion of the Mg-Ca alloy. Newly developed set of RESOMET implants have the mechanical strength, ability to stimulate bone growth and controlled slow degradation rate to be considered as an ideal candidate for biodegradable implant applications.

Working closely with major hospitals in Korea, we have performed over 200 cases of small bone fixation screws so far and the screws were approved for sale in Korea by MFDS (Ministry of Food and Drug Safety). Results of clinical tests were published on PNAS.



Magnesium Alloy Electric Bus Skeleton

PRODUCT INFORMATION

Name of Part or Process: Magnesium Alloy Electric Bus Skeleton

Product Using Part: Body Skeleton Using Magnesium Alloy Extruded Profiles

Function of Part: Offers Lightweight Skeleton for Body

Alloy Used: ZTM630 and ZK61

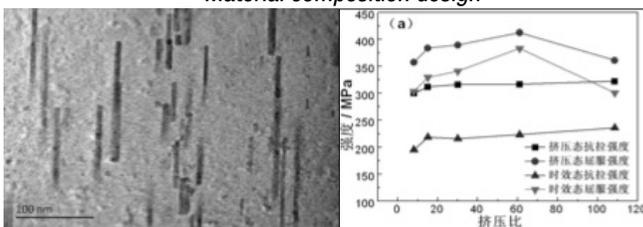
The IMA Award of Excellence winner in the Wrought Product Category is Advanced Materials Institute, Shandong Academy of Sciences, and China Magnesium Association. The world's first lightweight magnesium alloy electric bus was produced in Shandong province. The bus is 8.3 meters long, containing 24 seats. The bus body frame is totally made up of 226Kg magnesium alloys, which is 780/110Kg lighter compared with that of steel/aluminum alloys.

A novel magnesium alloy of Mg-Zn-Sn-Mn was developed and the yield strength (YS) and ultimate strength (UTS) for as-extruded Mg-6Zn-3Sn-0.5Mn (wt.%) alloy could reach 383 MPa and 412 MPa, respectively. The yield strength (YS) and ultimate strength (UTS) for as-extruded ZK61 alloy could reach 285 MPa and 336 MPa, respectively. Nine kinds of magnesium alloy extruded profiles were used in the bus body frame. All of them were conducted with F-free and Cr-free phosphating technology to improve the corrosion resistance.

By adopting lightweight magnesium alloys, the following advantages of the electric bus were obtained: improved mileage, shorter braking distance and reduced noise.

TECHNOLOGY INNOVATIONS

Material composition design



A novel magnesium alloy of ZTM630 was developed. Ys and UTS are 383 MPa and 412 MPa.

Profile extrusion and connection



9 kinds of extruded profiles were used in the bus body frame.

Surface treatment



F-free and Cr-free phosphating technology to improve the corrosion resistance.



FGS Technology Takes Environmental Responsibility Honors

PRODUCT INFORMATION

Name of Part or Process: FGS Technology for Magnesium Hot Chamber Die Casting

Product Using Part: Die Casting Mold, HPDC Process Controller

Function of Part: New Die Casting Process

Alloy Used: AZ91 and AM60

The IMA Environmental Responsibility Award winner is Oskar Frech GmbH + Co. KG. The FGS technology is the consequent further development of the Hot Chamber Die Casting process with the primary target of mostly eliminating the customary runners in a die using a hot runner technique and corresponding HPDC process control.

The challenges in HPDC of non-ferrous metals are quite significant when developing a hot runner system. Using Mg alloys, which have rather high melting temperatures, this requires a specific heating technology, equipped with very good temperature control. So the precondition in HPDC is to have a powerful close-loop temperature controlled casting unit.

Due to metal casting process, the system has to be extremely robust and with excellent tightness, so it can stand functioning in operation as well as during start-up procedures, when strong thermal expansion take effect.

In the HPDC process there is no possibility to put locking elements in the die, since during the die open period, formation of Magnesium oxides are possible, which will interfere proper operations.

The FGS technology has a great number of advantages, which in the above matrix. Measurements have shown that the hot runner system significantly relieves the classical temperature control of the die and the casting system. This means that the overall energy consumption is less. The electrically heated casting system requires more than 50% less than conventional heating and the FGS system reduces the energy consumption for die temperature by 11%. This energy saving is associated with a corresponding reduction in CO2 emissions during die casting. Approximately 38 t CO2 is thus avoided for casting a 320 g Mg part with an annual production of 660,000 pieces.

Thus, the FGS technology is a milestone in HPDC.

Die Casting Technologies			
Comparison on Energy Consumption per Part			
Comparison on energy consumption per part*	Standard Machine Gas-heated gooseneck and nozzle	Standard Machine Electrically heated gooseneck and nozzle	Standard Machine FGS technology
Die Casting Machine	48 Wh	48 Wh	48 Wh
Furnace	43 Wh	43 Wh	43 Wh
Gooseneck and nozzle	Gas > 62 Wh 	Electric 31 Wh 	Electric 31 Wh 
Die heating/cooling device	201 Wh	201 Wh	144 Wh
FGS system	. 	. 	21 Wh 
Total (energy per part)	> 354 Wh	323 Wh	287 Wh

* Production of same part; DAM 200

IMA congratulates all Awards of Excellence and Environmental Responsibility Award Winners who are dedicating their efforts to magnesium process and product innovations, setting ever-higher standards for making more efficient and environmentally responsible operations. These award-winning companies have found ingenious ways to produce, process, design, and build the global magnesium industry. They are demonstrating what is possible, and inspiring others to achieve even greater goals with magnesium innovations.



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

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