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.
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.

**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  

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

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

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| Steel design - 14 components and 105 welds | Mg casting design - 5 components, 6 isolators and 13 fasteners |
Magnesium Wheel for Super-Sport Motorcycle

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

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.

NAME OF PART or PROCESS: Front & rear die cast wheels 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

YZF-R1 2015
Biodegradable Magnesium Alloy for Orthopedic Application

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 a 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.

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

Schematic of Selected Clinical Trial

Before Surgery  |  After Surgery  |  After 6 Months  |  After 1 Year
--- | --- | --- | ---
Scaphoid Fracture  |  Mg alloy Screw  |  Degraded Mg alloy Screw  |  Complete Degradation & Bone Healing
Distal Radius Fracture  |  SS Pin  |  |  

www.intlmag.org
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.
Mg Showcase

FGS Technology Takes Environmental Responsibility Honors

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.

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<td><strong>Comparison on energy consumption per part</strong></td>
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<td>Gooseneck and nozzle</td>
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<td>Die heating/cooling device</td>
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<td>FGS system</td>
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<td><strong>Total (energy per part)</strong></td>
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* Production of same part; DAM 200

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
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.