2007 Abstracts

Magnesium Vision 2020, A NA Automotive Strategic Vision for Magnesium
Gerald S. Cole, PhD, FASM, LightWeightStrategies LLC
This manuscript dissects the recent 43-page monograph, “Magnesium Vision - 2020 Strategy”, sponsored by the U.S. Automotive Materials Partnership. Technical and infrastructural challenges have inhibited magnesium components to ~ 6 kg/vehicle (even though 150 have been approved by the auto industry). 163 R&D themes (projects) are developed to make Mg more competitive: 70 address the technical challenges: cost and quality (19), corrosion (35), and fastening/joining (16). 93 RDT’s examine new manufacturing technology: 34 examine non-HPDC casting methods and 59 analyze wrought processing. Several new component applications are proposed as well. Unlike aluminum, polymers and steel, there are no full service (FS) suppliers who research, design, manufacture, certify and provide implementation-ready magnesium-based components/assemblies to OEM’s. A magnesium center of excellence is proposed that would cyber-integrate global scientists, engineers, and automotive manufacturing/product development specialists. They will develop new modeling capabilities that could predict Mg component/vehicle behavior, thereby leading to new competitive products.

Mass Production Technology of Mg Coil by Strip Casting and Coil Rolling Process in POSCO-RIST
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To meet the recent increased demand for low cost Mg sheet products in electronic and automotive industries as the lightest structural materials for use in reducing weight and carbon emissions, POSCO-RIST have launched the program for developing the mass production technology of Mg coil by strip casting and continuous coil rolling process in 2004. As results of the program, AZ31 Mg cast strips of 600 mm width and 3.0 to 7.0 mm thickness have successfully been produced for up to 19 hours with several Mg coils of 1250 mm diameter. With optimized heat treatment conditions, a high speed reversible warm rolling process of strip cast AZ31 coils with maximum width of 600 mm and thickness down to 0.5mm has been developed successfully. The microstructure and mechanical properties of as-cast and as-rolled AZ31 sheet show that the new integrated process can produce qualified and cost-competitive Mg alloy sheets. With this successful development of production technology, POSCO-RIST have decided to install the commercial Mg coil production plant with updated post treatment facility till mid 2007.

Extruded Magnesium Alloys for Structural Applications
Prof. Dr. Karl Ulrich Kainer
While magnesium cast components have found their application the interest is now spreading to wrought alloys due to the more homogeneous and better properties compared to cast parts. The complex mechanisms of deformation, recovery and recrystallization influence the property profile and are important for understanding the needs of a process development. In addition the application of magnesium wrought components lacks in a better understanding of the influence of a thermo-mechanical treatment such as extrusion on the properties of the resulting parts. The development of new alloys and the optimization of the extrusion process - beginning with the continuous casting of billets and ending with the post-processing - deliver solution to overcome technical and economical restrictions for introduction of magnesium extrusion into applications. This presentation gives an overview on the actual status of the process and alloy development of extruded Magnesium wrought alloys. Enabling technologies for the introduction of parts in the transportation industries are discussed.

A Changing World with Different Rules - New Opportunities for Magnesium Alloys?

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The magnesium industry has seen significant growth and change over the last 15 years. Growth has been driven by the automotive industry and China now dominates the production of pure magnesium, supplying 70 – 80% of the world market. The paper reviews the drivers behind the growth of magnesium in the automotive industry and the impact of weight reduction on lifetime fuel costs. An economic comparison is then made showing the benefits of weight savings in aircraft design versus the benefits in automotive design. The comparison highlights that the benefits of weight saving in aircraft design are an order of magnitude greater than in automotive design. This raises the question as to why there is so little magnesium used on today's commercial aircraft? The paper reviews the main reasons for this anomaly and attempts to separate fact from fiction, particularly in relation to the IATA (International Air Transport Association) ruling of 1979, which essentially "banned" the use of magnesium on commercial aircraft. It is argued that today the world climate is very different to that of 1979, particularly with regard to environmental pressures, energy & fuel costs and the profitability of the airline industry. Aligning such changes with the significant advances made in magnesium alloy technology leads to the conclusion that in 2007, the climate is right for the ruling of 1979 to be challenged and for the airline industry to begin exploiting the valuable properties of this lightweight material.

Magnesium Recycling: Flux versus Flux-Free Processes – Principles, Advantages and Disadvantages

James E. Hillis

The continued growth of magnesium die cast applications in automotive, electronic, and other applications requires that casting scrap be refined and recycled economically to its original specifications with regard to both metallic and non-metallic content. Major recyclers and primary magnesium producers continue to use flux based processes for both alloy production and recycling with only a few exceptions for special alloys. Die casters, however, have adopted both flux and flux-free processes for the in-house recycle of casting scrap in recent years. The basic principles of both the flux and flux-free processes will be reviewed based on fracture brightness measurements of metal cleanliness. Measurement is the first step in quality control, while other competitive methods exist for the measurement of inclusion content; the simplicity, low cost, and speed of the brightness technique has allowed it to used to good benefit in understanding the basic behavior of oxide inclusions in both fluxless and flux based refining as well. In addition to the principles of separation some of the basic advantages and disadvantages the processes will be reviewed.

On the Construction of the Safety Standards Architecture in Magnesium and Magnesium Alloy Industry

Cao Yang

With the increasing demands for high speed, energy saving, environment protection and lightweighting from all walks of life, the application of magnesium and magnesium alloy die-casting parts becomes promising in such industries as automobiles, computer hardware and communication. Because the magnesium has the characteristics of flammability and explosibility, so to some extent, there is a hidden trouble of security accident in the production and in the recycle process of magnesium and magnesium alloy. The article is based on the harmfulness from the characteristic of magnesium and magnesium alloy and analyzes the different kinds of fatalness existing in the production cycle life of magnesium and magnesium alloy industry and also analyzes the establishment and implementation of the safety standards of magnesium and magnesium alloy die-casting at home and abroad by now. The article also describes in details the main issues of the construction of safety standard architecture for magnesium and magnesium alloy industry.

Global Climate Change and the Magnesium Industry – Progress Report on Public/Private Cooperation

Scott Bartos, Enviromental Protection Agency

The U.S. EPA proposes to co-host the 3rd Magnesium Melt Protection Users' Group Workshop along with the IMA, CMA, and JMA at the 2007 conference in Vancouver. The focus of this workshop is global climate protection and the magnesium industry's effort to eliminate emissions of sulfur hexafluoride (SF_6), an extremely potent and persistent greenhouse gas. In addition to leading this year's workshop, EPA is willing to make a presentation at the conference on current climate change policies, a proposal to help organize a global magnesium industry climate protection partnership, and/or recent evaluations of alternative, more environmentally friendly melt protection technologies.

Background: The International Magnesium Association (IMA) and the U.S. Environmental Protection Agency (EPA) are working together to address the challenge of climate change. This partnership between industry and government is seeking to elevate climate protection above the fray of normal industry competition and cooperatively find solutions to benefit the entire industry as well as the environment. Magnesium is poised to become a very climate friendly material; its light weight and strength enables the design and construction of the 21st Century's most fuel efficient vehicles. IMA and EPA share the goal of eliminating SF_6 emissions from magnesium production and casting thereby further improving the industry's environmental performance and sustainability. EPA wishes to expand the industry's cooperative effort and facilitate greater and more regular information sharing so that the entire industry may quickly and cost effectively eliminate SF_6 emissions and focus on the material's environmental benefits.

Impact of Carrier Gases on the Magnesium Melt Protection

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In order to reduce the green house gases usage, several alternatives to SF6 for Mg melt protection are proposed to the diecasting industries. However, most of the gases and the relative equipments are not available in the market. Coping with the rapid growth of Mg diecasting in 3C products enclosures application in the following years, a reliable and low cost protective gas must be well selected. In the paper, evaluation of using SO2 with nitrogen, CO2 and dry air in Foxconn will be reported. Based on the result, the SO2 is successfully applied in both hot chamber and cold chamber diecast processes. The result also shows that the carrier gases have great influence on the characteristics of the protective oxide layer on the melt.

Lost Foam Casting of Magnesium Alloys for Automotive Applications

Yemi Fasoyinu

Majority of the magnesium components used in automotive applications are produced by the high pressure die casting process because it lends itself to high volume production and reduced cost. Some automotive components are impractical to be produced as die castings for many reasons. For example, some of the high temperature and creep resistance magnesium alloys are prone to hot tearing when poured in metal molds during gravity and high pressure die casting operations. With the increased emphasis on vehicle weight reduction, automotive components such as engine blocks and heads and other power train applications could be produced by the lost foam casting (LFC) process from magnesium alloys to take advantage of its high-strength-to-weight ratio. The application of vacuum or low pressure during LFC process can improve mold filling and casting quality. This paper gives a brief overview of current global trend of magnesium lost foam casting research, and discusses some of the issues encountered during the casting of prototype components at CANMET Materials Technology Laboratory from some magnesium alloys that could be used in automotive applications.

Magnesium Die Casting with New Cover Gas

Masaki Furuta, Tokai Rika CO., LTD. / Hiroshi Sanui Taiyo Nippon Sanso Corporation

Molten magnesium tends to ignite and burn when it comes in contact with air. Therefore, SF_6 (sulfur hexafluoride) has been used as a fire-retardant gas (cover gas). However, since SF_6 has a large global warming potential (GWP) of 22200, it has been reduced and is about to be restricted in use. Under such circumstances, Taiyo Nippon Sanso Corporation has developed a new cover gas for molten magnesium. The major component of this cover gas is Novec^{TM}612, a fire-retardant agent with a GWP of 1 developed by 3M in the United States. Tokai Rika Co., LTD. researched an application of the cover gas to magnesium die casting with Taiyo Nippon Sanso and finally has introduced the cover gas and a supply system to the mass production. An outline of the new cover gas, experiment results of the cover gas for magnesium die casting, and the latest mass production situation are described.

Magnesium Die Casting in Hot Chamber and Cold Chamber Process: A Comparison of both Processes, Examples out of Practise and latest Developments in High Pressure Die casting especially for thin-walled parts

Dr. Norbert Erhard, Ulrich Schraegle

High pressure die casting of magnesium parts can be done in hot chamber process as well as in cold chamber. In the past the rule to decide the appropriate process was: to use for small parts the hot chamber process and for big parts the cold chamber process. However a comparison of both processes shows that instead of part weight other criteria, which relay more on the process of die casting itself, are a lot better to differ pros and cons. Examples given in practice proof the given statements. More over there are presented latest developments on high pressure die casting of magnesium, which improve process capability. This gives new prospects, especially for thin-walled die casting parts.

Squeeze Casting of High-Integrity Magnesium Components

Rich Jacques, SPX- Contech

This paper will describe a new process under development at SPX-Contech for squeeze casting magnesium components. Squeeze casting has been successfully used for many years to make aluminum components requiring high strength, ductility, or pressure tightness. The squeeze casting process applies slow fill plus continuous pressure throughout part solidification to minimize porosity formation and air entrapment. This combination of low-turbulence fill and high pressure yields thick-walled parts that can be heat treated to obtain mechanical properties suitable for high-integrity applications. Until recently only a limited amount of work has been done to apply the principles of aluminum squeeze casting to magnesium. An overview of the process will be given, plus information on testing, microstructures, and resultant mechanical properties of alloys before and after heat treatment will be presented

The Roll Casting –Hot Rolling for Magnesium Alloy Sheet

Hualun Li

We have developed a low-cost method for commercially producing magnesium sheet. The equipment consists of a system of magnesium melting and metal liquid supply, a twin rolling caster, a hot roller, a cutter etc. Commercial qualityAZ31B, MB8 and MB26 sheet of 600mm wide have been successfully produced. We studied the forming processing of roll casting and hot rolling, properties and microstructure of sheets. The results show that the key factors are the stability of the molten metal temperature, the pressure head in the tundish, the thermal insulation capability of the mouth, roll casting speed and hot rolling parameters

Report on China's Magnesium Industry Development in 2006

Meng Shukun

In this article, the development of the China's magnesium industry in 2006 is introduced, with the updated data of primary & alloyed magnesium output and statistics of exports & domestic consumption. Meanwhile, the progress and major problems in the industry in 2006 are analyzed. Especially, some new measures, including high-temperature air combustion technology with the heat-storage mechanism, energy retrench, drainage controls, environmental improvement and cost reduction, are mainly stressed. This article will also give some examples of magnesium alloy plate & sheet development and applications to show that, it is a must for Chinese magnesium industry to adjust its industry structure and upgrade its development level.

At last, this article will show you the structure of magnesium alloy technologies patented in China in the recent years. The research hotspots now in China will be further analyzed.

Development of Low-Cost Magnesium Extrusions for Automotive Applications

Alan A. Luo Anil K. Sachdev and Raja K. Mishra, General Motors Corporation

This paper summarizes the development of a low-cost wrought magnesium alloy AM30 (Mg-3%Al-0.3%Mn) and the high-speed extrusion process as well as the subsequent forming processes (bending and gas forming) for making tubular automotive components. Extrusion limit diagrams were developed to optimize the extrusion process for magnesium alloys. Detailed microstructural study and the polycrystalline plasticity simulation have led to the development of the moderate temperature forming processes. Potential applications of magnesium extrusions, such as engine cradle, instrument panel beam and front end body structure will be discussed.

Net-Shape Forming of Thin Wall Components from Magnesium Alloys

Frank Czerwinski, Development Engineering, Husky Injection Molding Systems Ltd

Recent developments in application of magnesium for thin-wall components of consumer electronics (3C) and other market sectors are reviewed. The conventional and novel manufacturing routes based on solid, semisolid and liquid states are characterized along with a comparison of benefits and drawbacks. While considering the casting process, a particular attention is paid to requirements, imposed on alloy properties both in the molten state and after solidification. An advantage of controlling the melt temperature and its flow into the mold is emphasized. The processing details are accompanied by recent advances in hardware design, aimed to optimize melt preparation parameters and its distribution systems into mold cavities (hot runners). A number of directions for alloy development are defined and examples of new alloys, proposed recently worldwide, are given.

Lightweight Magnesium Spare Tire Carrier

Christopher J. Duke, Stephen D. Logan, DaimlerChrysler Corporation

This paper describes a magnesium spare tire carrier developed at DaimlerChrysler for the 2007 Jeep Wrangler. This carrier replaces a stamped steel mounting bracket and separate injection molded plastic CHMSL module that were installed separately at the assembly plant. The magnesium carrier is responsible for a weight reduction of 70% at minimal cost penalty. The carrier is attached to the swing gate and is required to support spare tires weighing up to 75 lbs. The unit had to pass durability testing including 14,000 slams of the swing gate with the full 75-lb. spare tire weight attached and had to meet full exterior corrosion requirements. Since the spare tire is the first area of the vehicle that gets struck in rear impact situations, the carrier also had to survive a 50 mph rear impact test without becoming detached from the vehicle or allowing the spare tire to become detached.

Investment Casting Elektron 21- An Aerospace Magnesium Alloy Solution

Steve Heaney, Paul Lyon, Ismet Syed, Tim Wilks

Sand cast magnesium alloys are used in numerous aerospace applications including helicopter transmissions and jet engine components where light weight is important. However to take better advantage of the material, parts with thin sections must be produced. This can be done using investment casting, but this has always been risked reaction between the mould and the alloy, particularly at thicker sections. The new alloy Elektron 21 has been developed for both sand and investment casting. The low reactivity Elektron 21 gave successful results investment casting (using plaster and shell moulds) of larger parts with thick bosses as well as thin walls. Using improved processing technology it has been shown that large components can be made successfully in this alloy without reaction. This opens new opportunities for further weight reduction in weight sensitive applications