China Magnesium Development Report in 2013
Professor Xu Jinxiang, China Magnesium Association; China

China magnesium industry developed upward in a good and steady way in 2013 along with the slow recovery of the world economy. The report released the output; exports and consumption of magnesium in China in 2013, all of these are the highest in the history. New progress of R&D and application of magnesium alloy was outlined. The main work and development goals of china magnesium industry in 2014 were presented too.

Japan Magnesium Market Outlook
Daisuke Konishi, Advanced Material Corporation; Japan

Reporting about the Magnesium market situation based on the analysis on Import & Export statistics & our own investigation on domestic production data in the first section.

Then, focusing analyze into recent movements & tendency surrounding its market in Japan. The production of magnesium alloy parts for Automobile, laptop PC, Cell phones, Digital cameras had been booming up in the first half of 2000’s, but the sharply climbing the International market price during Beijing Olympic games & very high exchanging rate for Yen after Financial crisis had almost killed this industry.

As a result, not like other areas, Aluminum additive usage shares over 50% of its 40,000t of annual demands in Japan.

Japan has no domestic producer after shut down of 3producers in 1992 & depends on China for 95% of supply. So, the urgent required things are 1) Diversification of the suppliers & 2) Developing new applications. Currently, we are trying to develop the body for the High speed express train, Batteries, Motorcycle parts, Rolling sheets for phone parts etc.

Laser Beam Melting of Magnesium Alloys
Dominik Schmid, Institute for Machine Tools and Industrial Management –Application Center Augsburg, Technische Universität München; Germany

Arising of the prototyping branch the additive manufacturing processes have established in different industries. Current beam melting technologies offer the possibility to generate dens and high durable parts with complex formed shapes. The processing of metals like iron, aluminum, nickel or titanium is commercially available. The use of magnesium is still under research.

This article gives a general overview over the latest developments in additive manufacturing with focus on magnesium. It will point out current difficulties in terms of direct part production and feasible solutions. The process chain containing pre- and post-processes is discussed with regard to possible safety issues. Concluding the potential of additive manufactured magnesium parts is predicted and future fields of application are shown.
Development of the Process for Magnesium Production by Electrolysis from Oxygen-Containing Magnesium Raw Materials
Dr. Viktor M. Protsenko, Zaporozhye State Engineering Academy

Theoretical basis is given for a new process of magnesium production by electrolysis of solid magnesium hydroxochloride (MgOHCl) charged into electrolytic cells. The raw material is fed to anolyte separated from catholyte with a porous diaphragm. Economic and environmental advantages of this process are due to the application of a cheaper raw material and the absence of chlorine evolution in the course of electrolysis.

Surface Treatment of Magnesium Sheet Components in Transportation Industry
Ilya Ostrovsky, Chemetall GmbH

Magnesium, as the lightest construction metal, has a high potential to offer cost effective options for weight reduction in external and internal structure components in transportation industry. Last years, magnesium sheet has been investigated for application in aerospace industry. Automotive industry always expressed interest in application of magnesium sheet. However high material cost, low surface quality and corrosion resistance limited utilization of the magnesium sheet by only few components.

Recent developments of new magnesium sheet manufacturing methods, such as twin-roll casting, significantly reduced cost of the material.

Advanced magnesium surface treatment technologies developed by Chemetall GmbH offer solutions for aforementioned surface problems: chemical trimming of magnesium sheet and corrosion protection. In aeronautic field, Chemetall GmbH provides advanced technologies for functional improvement of magnesium sheet, flammability protection and corrosion resistance.

The presentation gives up-to-date information about the surface treatment technologies with test results and examples of applications.

Formation of Anticorrosive Film on Mg Alloy Using Steam Coating
Dr. Takahiro Ishizaki, Shibaura Institute of Technology

In recent years, a reduction in weight of materials is highly desirable in the fields of transport industry and information technology devices. Magnesium alloys have excellent physical and mechanical properties, such as, low density, good electromagnetic shielding, and high strength/weight ratio. Unfortunately, they have a great issue that is low corrosion. Thus, it is very important to develop surface treatment technologies to improve the corrosion resistance of magnesium alloy. Many surface treatments such as chemical conversion, anodic oxidation, and electroplating have been developed. However, there processes require multi-step pretreatments and waste liquid treatments. Thus, the development of a simple easy, and low-cost surface treatment is highly desirable. In this presentation, we report a novel preparation method of anti-corrosive film on Mg alloy by steam coating and the corrosion resistance of the film.
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Studies on the Magnesium Alloys Cladding in the Plastic Forming Processes (die forging & extrusion)  
Using as the Clad Layer of Corrosion Resistant Aluminum Alloys  
Piotr Korczak, Institute of Non-Ferrous Metals in Gliwice Light Metals Division

The study was conducted in order to improve the corrosion properties of magnesium alloys by forming on the surface a thin layer of aluminum alloy. As the feedstock material MgAlZn alloy (AZ series) have been used. Cladding process was realized in direct and indirect extrusion process. As feedstock to extrusion process billets with sleeve pipe (cladding material) pressed on them were used. The resulting claded rods have been used for forging process trials, which allowed determining their susceptibility to further plastic forming. After forging micro- and macrostructure of samples were tested, paying particular attention to the welding zone of both materials (claded alloy and clad layer). In the final stage of work forgings used in trials in salt spray chamber which allowed verifying the corrosion properties of technology being developed.

Development of a High Pressure Die Cast Magnesium Cross Car Beam for Automotive “Platform” Application  
Andrew Tippings, Meridian Lightweight Technologies UK Ltd.

With ever increasing legislation, the need for OEMs to utilise light weighting materials and techniques in the automotive industry has never been in such focus as it is today. Although magnesium technology is established in the automotive marketplace, the challenges are increased as OEMs push hard to reap the commercial benefits of cross platform sharing and process efficiencies.

Meridian Lightweight Technologies is at the forefront of product design, manufacturing and supply of large structural magnesium die cast components for the auto industry.

Working closely with our OEM customer we established the business case for a lightweight cross-platform magnesium cross-car beam. Through a collaborative product development cycle, the aggressive business case deliverables were preserved in the weight, performance and manufacturing strategy.

This paper will cover the cross car beam development from initial benchmarking through product design, manufacturing simulation and part manufacture.

New Magnesium Applications  
Diego Val Andrés, Grupo Antolin Ingeniería;

New environmental standards related to CO2 emissions lead to the automotive sector to develop lighter solution. In this scenario, Magnesium is a strategic lightweight material. In the following paper, Grupo Antolin explains the development of a Magnesium carter application for an electrical vehicle as a feasible alternative to current solution. Since the selected Magnesium component is a part of the electric motor, the part has to fulfill different requirements (sealing, thermal dissipation, corrosion resistance, vibro-acoustic..., etc). For this purpose, Grupo Antolin shows its experience and capabilities at each critical processing steps, design, development, manufacture and validation.
Expansion of Thermally Rolled Magnesium Coils into Mobile Devices
Dr.-Ing. Kazumasa Yamazaki, Nippon Kinzoku Co. Ltd.

Thermally rolled magnesium coils or sheets have been applied to Note PC covers since 2002. It did not spread rapidly because there was not so strong demand for reducing the weight. But, in last few years, the demand for weight reduction becomes stronger due to intense competition among mobile devices provider. Under these situation, we started to provide suitable magnesium coils for mobile devices. The thickness of the coils are 0.2 to 0.3mm, and they have chemical treatment layer which has conflicting properties of electrical conductivity and corrosion resistance. These properties are very important for mobile devices. Now, both production technology of thin magnesium coils and developed chemical treatment contribute to expanding magnesium sheets into mobile devices.

Influence of an Asymmetric Shear Deformation on Microstructure Evolution and Mechanical Behavior of AZ31 Magnesium Alloy Sheet
Dr. Bin Jiang, National Engineering Research Center for Magnesium Alloys, Chongqing University

Conventionally extruded Mg alloy sheets possess poor mechanical properties due to the strong basal texture where c-axes of the grains are predominantly aligned parallel to the sheet normal. This brings about a poor deformation capability of sheet thinning and a stronger anisotropy and consequently results in limited number of available plastic deformation modes. In this work, a novel extrusion approach to get high strength magnesium alloy plates will be introduced through differential speed processing. A suitable constitutive model of differential speed extrusion is established to ameliorate the texture-dependent mechanical properties. The velocity evolutions of the extruded sheets at near-surface and mid-layer region are different due to the extra asymmetric shear deformation. This simple shear enforces the near-surface microstructure to exhibit more dynamically recrystallized grains having the c-axis tilted toward the extrusion direction. The yield stress of AZ31 alloy sheet has been increased from 161.2 MPa to 179.9 MPa and the elongation has been improved from 15.4 % to 20.1 %. Moreover, as for the high strength AZ61 alloy sheets, the ultimate tensile strength was increased from 387.9 MPa to 427.1 MPa and the yield stress was improved from 147.7 MPa to 195.9 MPa. Grain refinement and tilted weak basal texture obtained by differential speed extrusion process. This approach is an efficient substitute to increase the texture-induced softening and ductility and thus favorable for the thin sheet fabrication.

Increasing the Applicability of the 2013 IMA Life Cycle Assessment Study of Magnesium
Dr.-Ing. Lindita Bushi, ATHENA Sustainable Materials Institute

Magnesium’s unique characteristics make it suitable for a variety of different applications. It’s typically used in lightweight applications without compromising the overall strength and other physical properties. Today, magnesium alloy products and magnesium ores are used globally in a variety of applications covering a wide range of sectors such as automotive, aerospace, medical, electronic, building and construction, non-structural, sports etc.

This paper looks at the strategies and paths to increase the applicability of the critically reviewed 2013 IMA Life Cycle Inventory (LCI) data (such as primary magnesium production, magnesium processing and
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recycling of post-consumer scrap) to all relevant sectors; and develop additional new LCI datasets for magnesium products of interest such as magnesia based board products.

Furthermore, it will provide a comprehensive procedural roadmap for the IMA members when considering the development of PCRs and EPDs based on the LCA for magnesium products.

A New Family of Creep Resistant HPDC Magnesium Alloys with Superior Combination of Strength and Ductility
Dr.-Ing. Nir Moscovitch, Dead Sea Magnesium Ltd.

In recent years significant progress in weight reduction has been made in the transportation industry as well as consumer applications of magnesium alloys such as power hand tools, lawn and garden equipment, electronic and optical equipment, etc. However, in order to significantly expand the above applications and pave the way to new ones, advanced alloys with improved properties are required. This paper represents a review and summary on the development of a new family of high-pressure die cast creep resistant magnesium alloys that outperform all known magnesium alloys in combination of creep resistance, strength and especially ductility. The metallurgical principles underlying superior properties of new alloys are disclosed and discussed.

Development of High Strength Magnesium Alloy Bolts Using Optimized Processes
Dr.-Ing. Shigeru Yamanaka, Maruemu Works Co., Ltd.

Magnesium alloys are expected to contribute to automotive, rail, and aerospace industries for its lightweight by reducing fuel-consumption and carbon-dioxide. Fastening these parts, magnesium-alloy-screws are considered to be the best in terms of chemical and physical characteristics by avoiding electric corrosion and thermal stress. In addition, distribution of stress in the fastening regions becomes moderate because bolts and fastened parts have similar mechanical properties. Moreover, the resistance against bolt-loosening is also expected due to its low Young’s modulus.

To make the most of these features, a high-strength and high-creep-resistance have been demanded on the screws for their practical use. Simultaneously, magnesium-alloy billets are required to be strictly controlled concerning purity, segregation and alloy elements to ensure the reliability. Maruemu Works started manufacturing newly-developed-Mg alloy bolts in collaboration with Tobata Seisakusho and Fuji light metal. In this presentation, the fastening features of these bolts are introduced with the recent developments concerning manufacturing processes and materials.

Magnesium Die Casting Technologies: A Comparison Based on Parts Requirements as well as Perspective on Innovation Potential of Magnesium Die Casting
Dr.-Ing. Norbert Erhard & Martin Schlotterbeck, Oskar Frech GmbH + Co. KG; Dr.-Ing. Carlo Bark, C&C Bark Metalldruckguss und Formenbau GmbH

High-quality components from magnesium can be manufactured economically in different die casting processes. The mechanical properties, the wall-thicknesses and surface conditions, the construction part
sizes, the parts arrangement, the number of units but also the design are important parameters for the selection of a suitable die casting process economical for each component.

The classical methods - the hot chamber and the cold chamber process - share the applications, taking into account the selection criteria listed. We look at the basic process advantages of both methods and go into detail on examples of the selection of the corresponding manufacturing process.

The previously known manufacturing methods are supplemented with the new gating reduced FRECH casting system "FGS" which is an evolution of the hot chamber process and has the focus to largely eliminate the existing runner system. The melt is brought close to the part and is available there for filling the part on the temperature level of the melt.

The comparison of the methods is thus supplemented by a pioneering technology variant. The paper shows the possibilities that the processing of the lightweight material magnesium in the die casting process has today and shows further potential for innovation in this technology.

**Development of UH Magnesium Alloy Chip for Forming Thixo-Mold**  
Makoto Hino, Hiroshima Institute of Technology; Yoshiaki Hashimoto, STU Co. Ltd.

Thixomolded AZ91D magnesium alloy has been applied as an alternative for plastic moldings in body frames for electronic equipment due to its high rigidity, thinness, light weight, good heat dissipation, high damping capacity, good electromagnetic shielding effectiveness, easy machining, and good recycling ability. For the forming thixo-mold, UH magnesium alloy chip containing 0.1 mass% carbon in the AZ91D magnesium alloy chip was developed. Since the fluidity of UH alloy was improved in comparison with the AZ91D magnesium alloy, thin thickness molding became possible. The minimum thickness was 0.28mm. In addition, mechanical properties of the UH magnesium alloy such as elongation and 0.2% proof stress were improved.

**Qinghai Magnesium Project Overview**  
Philip W. Baker, Hatch

The Qinghai Magnesium Project will create the world's largest primary magnesium production facility as the center piece of an integrated industrial complex producing magnesium and its alloys, PVC resin and soda ash as its primary products. Importantly the complex will utilize abundant clean energy, hybrid and photovoltaic solar, as its primary source of energy.

**A New Hydrometallurgical Process Combined with an Electrolytic Process for Magnesium Primary Production from Serpentine**  
Dr. Joel Fournier, Alliance Magnesium Inc.

The Pidgeon process has been the dominant process to extract magnesium metal over the last decade. Pidgeon process shifted the electrolysis previous domination to produce magnesium, as China was benefiting from a combination of advantages. In addition to available and low cost manpower, China was also in a position to take advantage of low cost and abundant dolomite, ferrosilicon and energy
(coal). With a minimal consideration for air pollution and process waste, China could impose its magnesium metal produced from the Pidgeon process. This resulted in most electrolytic process based smelters located in the Western world to close during the last decade.

With global pressure to meet stringent fuel economy standards, the transportation sector will drive a significant demand for light metal, including magnesium if this metal is available in necessary quantities with the required quality and environment profile, and without any trade or availability concern.

A private Canadian research team has work extensively over the last decade to improve the electrolysis process in order to position it on a competitive economical level with the Pidgeon process. Alliance Magnesium has developed and successfully tested a new magnesium smelting process sequence embedding significant technological improvements. Alliance Magnesium has successfully proved its capability to produce pure magnesium metal with its new process where the electric energy requirement has been significantly reduced and the environmental footprint has been minimized.

**Fault-Tolerant Composite Protective Coating for WE43 Magnesium Alloy**
Dr. Svetlana Lamaka, ICEMS, Instituto Superior Técnico, Universidade de Lisboa;

Inhibitor-enriched protective coatings are able to tolerate mechanical impact followed by corrosion attack. This is achieved via chemical interaction of corrosion inhibiting species with magnesium surface and formation of compact corrosion products that prevent further corrosion propagation and restore the main coating functionality: corrosion protection. Three main functional components contribute to success of a self-healing coating: durable polymer matrix, inhibitor carrier and efficient corrosion inhibitor. The presentation will describe our approach to composite protective coatings for WE43 magnesium alloy disclosing the details of all three main protective components. Special emphasis will be placed on newly identified corrosion inhibitors for magnesium alloys. The results of laboratory and industrial tests will be presented.