2010 Abstracts

China Magnesium Development Report in 2009

Mr. Meng Shukun, Mr. Wu Xiuming, Mr. Xu Jinxiang
China Magnesium Association

ABSTRACT
In this article, the output, exports and domestic consumption of primary magnesium and magnesium alloys in 2009 will be released. The data shows that due to crisis 2009 was a difficult and hard year for magnesium industry while the output, exports, domestic consumption and economic benefits dropped widely year-on-year.

Although economic conditions were depressing, something excited happened. Energy-saving & emission-reducing in magnesium smelters had been developing. Developments on R&D and application on magnesium alloy had been expanded.

It analyzed the economic conditions of China's magnesium industry in 2009. It also indicated that there are major problems and challenges China's magnesium industry faced. Some solutions will be given.

Key Words: China's magnesium industry, economic conditions, energy-saving & emission-reducing and magnesium alloy application.

A shift in strategy for the magnesium industry – A global alloy producer & recycler point of view

Dr, Ing. Martin Tauber, MAGONTEC

The magnesium industry has undergone an enormous shift during the last decade, both in global production pattern, and in commercial use in different industries.

In the beginning, this paper is intended to show after a short review of this shift in historf, a comprehensive overview about global competitive pricing of magnesium and its most likely rivals.

The majority of the paper will give a status quo of the different value drivers along the supply chain, mainly from the standpoint of a global alloy producer and recycler. Then, it will analyze the different needs in the value chain, and will try to draft needed commercial and market development strategies for the magnesium industry to maintain and to enhance its competitive position.

This paper will also try to draft needed actions to secure success for the upcoming 3rd input stream, the "post consumer scrap" again viewed from a recycler point of view.

The Vehicle Concepts of the Future and their Impact on automotive Mg-Technologies

Horst E. Friedrich, Institute of Vehicle Concepts, German Aerospace Center
Bernd Propfe, Institute of Vehicle Concepts, German Aerospace Center
Stephan A. Schmid, Institute of Vehicle Concepts, German Aerospace Center

Today's and tomorrow's struggle for alternative automotive technologies is fact. In the light of resource-efficient transportation and changing legislative environments, various vehicle concepts are trying to position themselves in the global market. Exemplary for the German market, the scenario based simulation tool *VECTOR21* incorporates all these objectives in order to determine future market penetrations of vehicle concepts by pursuing a least-cost-approach. 900 different types of customers, the entire spectrum of propulsion technologies as well as technical developments and cost evolutions are taken into account. The outcomes show that national and global political climate goals are feasible. However, since future developments are strongly dependent on general conditions such as subsidies and CO2-penalties or raw material prices the results can only indicate future market penetrations. Nevertheless, it becomes clear that due to increasing pressure on CO2-reduction efforts lightweight design will play a stronger role for future vehicle concepts, regardless of which propulsion technology will dominate the market. Hence, the magnesium industry is looking at a larger opportunity to position itself as a key player in these developments. This addresses environmentally friendly production processes as well as optimized parts and component designs for the vehicle architecture.

Influence of both economy and related commodities market on China's Mg industry and Forecast

Dong Chunming, Sunlight Metal Consulting （Beijing）Co., Ltd

Mg industry in China acts small-scale role in national economy, and fluctuates with economic situation and related factors. Commodities that bring about effect on Mg industry cover coal, coke, ferrosilicon, Al, Fe, Ti, automobile, steel and iron. This paper will review and analyze the relation between Mg industry and above commodities, with price, supply and demand, consumption and application as well as future forecast included. This paper, too, analyzes the influence of both economy and policy on Mg industry, and at the same time, lists suggestion on how to stabilize Mg market, how to realize win-win situation, and how to update commercial pattern.

Title: Magnesium Alloys in Aerospace Applications - Flammability Testing and Results

Bruce Gwynne, VP Divisional Strategic Development, Magnesium Elektron USA

Current Federal Aviation Administration regulations and other restrictions prohibit magnesium alloy for use in internal aircraft applications that would benefit greatly from its light weighting advantages. This paper reviews magnesium alloy uses in past and potentially new aerospace applications, and then focuses on the regulatory environment and magnesium fire testing evaluations in an effort to have these restrictions modified or eliminated. Flammability experiments conducted with the FAA using laboratory oil

burner type bench testing have found that rare earth containing magnesium alloys had a tendency to either not ignite or self extinguish. This is in contrast to traditional aluminum containing magnesium alloys that do not perform as well due to the lack of a protective oxide film. Actual in-aircraft full-scale flammability testing of traditional aluminum alloy and magnesium alloy aircraft seat structure components will be shown and discussed.

Design of hybrid Mg/Al components for the automotive body – Preventing general and galvanic corrosion

Dr. C. Blawert, Dipl. Ing. V. Heilmann, Dr. D. Hoeche, Prof. K.U. Kainer, GKSS Forschungszentrum Geesthactht GmbH
Dr. P. Izquierdo, Dr. S.G. Klose, Dr. H. Schreckenberger, Daimler AG

The hatch back of the new Mercedes Benz E-Class T-Model is one example for a hybrid design with inner magnesium high pressure die casting liner and outer aluminum sheet The hybrid rear door has to fulfill a variety of requirements corresponding to dimensional stability, weight, stiffness, crash and corrosion performance. The liner is one of the largest high pressure die cast applications for magnesium, but casting is not the only challenge. The hybrid concept in general as well as various interfaces and connecting points require a careful design to prevent galvanic corrosion. Critical connecting points are introduced and for two examples (gas pressure spring and hinge) the consecutive criterions are discussed. Finally the concept of corrosion protection measures and results of various testing trials of the component are presented.

Production of Hydrogen Storage Material MgH2 and its Applications

H. Uesugi, T.Suguyama, I Nakatsugawa, and T. Ito

Magnesium hydride, MgH2, is a promising candidate for hydrogen carrier in the next generation energy network. With its abundance of raw material and stable nature of MgH2, high capacity of hydrogen storage is suitable for massive utilization. We have succeeded in producing MgH2 powder in industrial scale, based on thermodynamic equilibrium. To solve the problem of poor kinetics of MgH2 in hydrogen release, which can attain hydrogen production yield up to 15.2 mass% under 100 □Ž. Examples of cartridge-type hydrogen production containers and their combination to PMFC driven commuter cars and wheel chairs are presented. The reaction product Mg(OH)2 can be reused for other applications, or recycled to Mg or MgH2 by effective reduction methods. The concept of MgH2 based energy network is finally proposed.

Magnesium Front End Research and Development: Phase I Progress Report of a Canada-China-USA Collaboration

Alan A. Luo . General Motors Research & Development Center, Warren, MI, USA
Wenfang Shi , China Non-Ferrous Metal Industry Association, Beijing, China
Kumar Sadayappan, CANMET - Materials Technology Laboratory, Ottawa, ON, Canada
Eric A. Nyberg , Pacific Northwest National Laboratory, Richland, WA, USA

The Magnesium Front End Research & Development (MFERD) Project is an international effort jointly sponsored by the Natural Resources Canada, the Chinese Ministry of Science and Technology (MOST), the United States Department of Energy and the United States Automotive Materials Partnership (a consortium of Chrysler, Ford and General Motors). The goal of the MFERD project is to demonstrate the technical and economic feasibility of incorporating a lightweight magnesium-intensive automotive front end body structure in multi-material vehicle architectures resulting in improved fuel economy and performance. This paper summarizes the progress made in the past three years (Phase I) of this Canada-China-USA collaboration in nine task areas: crashworthiness; noise, vibration and harshness (NVH); fatigue and durability; corrosion and surface finishing; extrusion and forming; sheet and forming; high-integrity body casting; joining and assembly; as well as the integrated computational materials engineering (ICME). Some of the Phase I accomplishments include: (a) development of super-vacuum die casting technology – produced the first-in-the-world weldable magnesium die castings; (b) fabrication of low-cost continuous cast Mg sheet with comparable mechanical properties and formability; (c) optimization of extrusion process parameters and process simulation tools (Deform 3D); (d) demonstration of several Mg and dissimilar metal joining and corrosion protection options – key to automotive applications; and (e) creation of significant knowledge base and computational tools in magnesium crashworthiness, NVH, fatigue and ICME.

Lifecycle Assessment of Carbothermal Production of Magnesium in Australia

Dr. Leon Prentice, Dr. Neil Wai; CSIRO Light Metals National Research Flagship

Ramakrishnan and Koltun (2004) and more recently Cherubini *et al* (2008) have used Life Cycle Assessment (LCA) techniques to assess the energy requirements and environmental impacts of a number of magnesium production technologies. Results have shown the Chinese Pidgeon process has a Global Warming Potential (GWP) of around 42 tonnes CO2 equivalent per tonnes of magnesium and the electrolytic process, around 24 tonnes CO2 eq. Detailed analysis of the carbothermal production process, which is under development in Australia by the CSIRO Light Metals Flagship, has not previously been undertaken. Recent achievements in the development of the process have provided important information for a detailed LCA, and preliminary assessment indicated the carbothermal process will be significantly less energy intensive and more sustainable than alternative options. The GWO of the carbothermal process in Australia is estimated as between xx and xx tonnes CO2 equivalent, depending on the source of electricity used.

Materials and Processing of Wrought Magnesium Components for Automotive Chassis Applications

Gerald S. Cole, LightWeightStrategies LLC ; Professor Siyuan Long, Chongqing University and Richard Osborne, General Motors Corporation, USA

Automotive chassis components are exposed to severe environment conditions of high loads, impact resistance, and corrosion prevention. In addition, there may be underbody temperature excursions that introduce creep as well as stiffness (modulus) concerns. This paper reports on research performed at Chongqing University that examines the use of wrought magnesium processing to produce chassis parts that can compete with current cast aluminum applications. The paper documents the vehicle requirements of one particular component, a control arm, and how an alloy and processing that meets the requirements were selected. A unique processing route was developed that produced specimens based on: billet casting → extrusion (to eliminate porosity) → forging (to get a more homogeneous structure) → heat treatment (to stabilize the structure). Property data will be presented that show the effectiveness of this protocol to produce a control arm that has sufficient tensile yield strength, ductility and stiffness to compete with the current aluminum part.

Development and commercialization of the electromagnetic continuous casting technology for Mg alloys billet

Joonpyo Park, Research Institute of Science & Technology

Currently, magnesium billets were produced by ingot casting or direct chill casting process, result in low-quality of surface and productivity. Continuous casting technology for high-quality surface billets with fine-grained and homogenous microstructure can be a solution for the cost barrier breakthrough. The latent heat of fusion per weight (J/g) of magnesium is similar to that of other metals. However, considering the heat emitted to the mould surface during continuous casting in meniscus region and converting it to the latent heat of fusion per volume, magnesium will be rapidly solidified in the mould during continuous casting, which induced subsequent surface defect formation. In this study, electromagnetic casting and stirring (EMC and EMS) techniques is proposed to control solidification process conveniently by compensating the low latent heat of solidification by volume and to fabricate magnesium billets of high quality surface. This technique was extended to large scale billets up to 300 mm diameter and continuous casting was successfully conducted.

Advanced fluxless recycling technology for magnesium alloys

T.Lahav, E. Aghion, Electrotherm

The growing demand for lighter structural materials be various industries including automotive, aerospace, electronics and household equipment has lad to increased use of magnesium alloys. This was mainly motivated by increased environmental concern that was consequently accompanied by relevant legislation especially in the EU and North America. The growing amount of magnesium alloys for high temperature applications that include alloying elements such as strontium, calcium and some of the rare earth elements that cannot be recycled by conventional flux processes due to the high affinity of those alloying elements to chlorine.

Hybrid Magnesium-Aluminum Profiles - Product and Process
Dr. Soeren Mueller, Extrusion Research and Development Center, TU Berlin

Despite its high potential for light-weight constructions the use of magnesium alloys in high-volume production cars is still very limited. Besides some other influences this is also due to the poor corrosion resistance of most wrought magnesium alloys. So in order to increase the use of magnesium profiles the corrosion Resistance needs to be improved. This can be achieved by coating the profiles after the extrusion. Unfortunately this would result in an extra production step and thus additional costs and time. A coating in the same step as the extrusion could overcome this problem. Therefore, the idea is to use the commonly used light alloy aluminum as a „coating“ for magnesium profiles. The profiles are manufactured by direct and indirect extrusion from specially prepared hybrid Mg/ Al billets. Hence light magnesium profiles with a corrosion resistant aluminum coating can be produced in a single production step.

Magnesium Alloy Sheet by Volume-Rolling
Hualun Li, Yuewang Xv, Yingguang Group CO.,LTD. China

Magnesium alloy is the first choice material for lightweight of vehicle. In recent years, It is the developing direction and the an inevitable stage that to replace steel and Aluminum sheet with magnesium alloy sheet in the car. The traditional production method of magnesium alloy sheet is low productivity, high production costs, poor quality consistency. This compound is not in line with the requirements of the automobile industry.

This article describes a new technology for magnesium alloy sheet rolling. The new technology includs roll casting on volume and a finishing mill roll on volume. Magnesium alloy liquid feeds into rolling caster and magnesium alloy sheet is made continuously. After softed by solution on-line the casting sheet is rolled into thin strip on volume and the tripe is rolled in a four-high rolling mill for the multi-finishing.

Application of Mg-RE Alloy in 3C Products
Lee Yuenfat Weiwei Shan W C Keung Norman Chan W C Wong, Ka Shui International Holdings Ltd

In this paper, improvement of fluidity of AZ91D magnesium alloy by mixing in rare earth elements is researched, and the influence mechanism of rare earth elements on magnesium alloy is studied as well. Experiment results show that the fluidity of AZ91D magnesium alloy improved by 7% and 35% with mixing in rare-earth elements KR1 &KR2 and KR1&KR2&KR3. The increased costs were controlled in 15 %. 3C Products experiments also carried out with AZ91D-RE alloy. The results show that the formability of 3C products improved obviously, especially for thinner notebook cover, at the same time, the corrosion resistance also improved significantly.

Development of engine cylinder mask using high-performance Mg-RE alloy

J.Meng, H.F.Liu, J.H.Zhang, X.P.Cui, D.P.Zhang, W.Sun, X.Qiu, D.X.Tang, H.Y.Lu;
FAW Foundry Co. Ltd., State Key Laboratory of Rare Earth Resource Utilization, Changchun Institute of Applied Chemistry, Chinese Academy of Science

A series of low-cost and high-performance Mg-Rare Earth alloy have been developed using the abundant resources of rare earth and magnesium in China. The new heat-resistant and creep-resistant Mg-RE alloy with the tensile strength 260-280MPa, creep deformation <0.15% (150□, 70 MPa), elongation about 5% was successfully achieved. The engine cylinder mask for 460 horsepower diesel fuel engine was successfully developed using new heat-resistant Mg-RE alloy in FAW Foundry Co. Ltd., first. The engine cylinder mask has passed the strict test and were been producing in 40,000 pieces per year in FAW. A lot of product in vehicle power system and other key parts have been developed using the heat-resistant and creep-resistant Mg -RE alloys.