

2011 Abstracts

Recent Development of New Types of Wrought Magnesium Alloys in China

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Many researchers in China are actively engaging in the development of new types of wrought magnesium alloys with low cost or with high-performances. The key R&D activities for the development of new alloys in China are reviewed, and typical properties of some new alloys are introduced. The compounds occurring in the new alloys and effects of micro-alloying elements on the microstructure and properties are discussed. More attentions are paid to high-strength wrought magnesium alloys, high-plasticity wrought magnesium alloys and ultra-light Mg-Li alloys. The research on phase diagrams of magnesium alloys has attracted an increasing interest recently, and some new phase diagrams have been finished. The research activities in China for the development of new alloys are carried out mainly in Chongqing University, Shanghai Jiaotong University and the Institute of Metals of Chinese Academy of Sciences. Some new alloys developed in China are found to have very satisfactory properties

Eco-Mg Alloys Update – Crashworthy, High Temperature & Fire-proof Applications

Shae K. Kim, KITECH, Korea

Eco-Mg (Environment COncious Magnesium) alloys are expected to cover all types of conventional Mg alloys by simply adding CaO and to achieve SHE targets together by improving flame resistance (Safety), eliminating SO₂ and Be addition (Health), and eliminating SF₆ (Environment). The main point of Eco-Mg alloys is that CaO is reduced to form only Mg₂Ca (C14) in pure Mg and Al₂Ca (C15) and/or (Mg, Al)₂Ca (C36) in Mg-Al alloys with α -phase in which there is almost no Ca solid solution. It can be possible without sacrificing process abilities, mechanical properties and cost.

This paper will cover the plain and simple approach of Eco-Mg alloys esp. for developing Mg alloys with high ductility, high temperature resistance, and fire-proof ability. Diecasting was performed for AM60B-(0.3~0.7)wt%CaO Eco-Mg alloys by using a Buhler 1,450-ton cold-chamber machine under dry air atmosphere without SF₆ and SO₂ gases. The issues of Eco-Mg for Al alloys and self-breakable desulphurizer will be also addressed.

Vision of POSCO Mg – from raw materials to products

Eun-Seong Min, Posco, Korea

Mg smelting plant will be constructed from Apr. this year to Jun. 2012 with the capacity of 10,000 ton per year. Through the 2nd and 3rd expansion, its capacity will reach 100,000 ton per year by the year of 2018.

POSCO is aiming to be a comprehensive material supplier beyond a steel supplier. POSCO will complete a full chain of Mg business from raw materials to products and lead a Mg business with roles of total solution provider and market creator.

China Magnesium Development Report in 2010

Mr. Meng Shukun, China Magnesium Association, China

The output, exports and domestic consumption of primary magnesium and magnesium alloys and powders/granules in 2010 will be released in this report.

Clean energy and the technologies of conserving energy & reducing emission had been widely adopted throughout the magnesium smelting industry in 2010 while the equipment levels had been improved to some extent. The energy consumption of magnesium smelting went down to 5tce/t·mg and the CO₂ emission was 11~12t/t·mg calculated by CMA. The new vertical retort technology showed a great potential of saving energy and reducing emission.

2010 also saw new progresses such as expanding magnesium alloy application and improving deep-processing technologies and equipments as well as restructuring and optimizing magnesium industry.

The 'REACH' status for Magnesium and post-registration activity

Tim Wilkes, Magnesium Elektron, UK

The MaREC consortium and Magnesium Elektron, as Lead Registrant, have completed REACH registration for magnesium metal. The presentation will discuss the process carried out by the consortium, the data collection requirements, and the outline the results. It will come to no one's surprise to learn that magnesium is non-toxic, but that it can burn when finely divided. However now we have formal data to support these assumptions. The output from the processes will be an Extended Safety Data Sheet that will be available to all members of the consortium and SIEF.

Alloys are considered to be mixtures under REACH, so the implication for magnesium alloy users will also be discussed.

3MTM Novec™ 612 Magnesium Protection Fluid Within REACH

Kurt T. Werner, 3M Electronic Materials, USA

3M™ Novec™ 612 Magnesium Protection Fluid is part of the family of 3M™ Novec™ fluids designed as replacements for ozone depleting substances (ODSs) and materials with high global warming potentials (GWPs). This paper will outline the properties that differentiate this product as a sustainable replacement for SF₆ as a cover gas in magnesium casting. In addition to the process understanding gained from commercial use, substantial understanding has been gained from trials in a wide variety of casting operations. These trials have led to an optimization of cover gas delivery to minimize both costs of conversions and greenhouse gas emissions. A more thorough understanding of the data generated to date will position Novec 612 as viable replacement not only for SF₆ but also for HFC-134a and SO₂. It is also important to note the recent commercial availability of Novec 612 in Europe in accordance with the REACH directive.

Rima's process: Green Magnesium from a fully integrated plant

Fernando França, RIMA, Brazil

The most prevailing methods of producing primary magnesium are the silicothermic and the electrolytic. Current technologies differ based mainly on the mineral resources used as feedstock, reduction process, source of energy and generation of by-products. Production capacity, required manpower, investment costs, and environmental legislation are key issues to be considered when choosing the ideal technology for a greenfield magnesium project.

Since the 1990's, the magnesium silicothermic processes have experienced a rapid growth mainly due to the introduction of the Pidgeon Process in China. Today, they are responsible for approximately 85% of the world total primary magnesium production and Pidgeon Process is by far, the dominant technology in terms of annual output.

For more than 30 years, Rima Industrial has been successfully operating a highly efficient silicothermic process in Brazil. Rima's process was originally based on the Ravelli Process developed in Bolzano, Italy, approximately 70 years ago.

The main differences between the Rima and Pidgeon processes are that the first one operates with internal heating (electric current passing through steel resistors), bigger retorts (approx. 2000Kg per cycle) and it shows lower labor, higher investment cost, much higher thermal efficiency and much lower emissions.

Today, Rima operates a 22,000 MTY fully integrated plant, producing metallic magnesium, several magnesium alloys, magnesium powder and magnesium diecasting parts on the same site directly from dolomite, quartz and charcoal.

This paper discusses Rima's magnesium production technology with special focus on the usage of environmental friendly resources such as charcoal and hydropower, as well as the processing for further application of all by-products generated. This unique combination makes Rima the world's only green magnesium producer today.

Key words: magnesium production, Rima's process, green magnesium

Challenges of the Magnesium Alloy Business

Dr. Trevor Abbott, Advanced Magnesium Limited, Australia

During 2008 the production of primary magnesium was severely curtailed due to measures to control air pollution for the Beijing Olympics. This led to a doubling of prices compared to 2007 levels and led to a major downturn in the use of magnesium alloys. Since that time there has been relative stability with prices returning to more sustainable levels. Magnesium alloy producers face many challenges in the current period. This paper discusses this recent history and the role that technology can play in differentiating producers.

keywords: magnesium alloys producers, economics, specialty alloys

Magnesium Automotive Body Panels Using GM's Quick Plastic Forming Process

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Hot blow molding or superplastic forming (SPF) of light metal sheet has been used to form intricate but expensive shapes for the aerospace and exotic land transportation industries. General Motors (GM) has developed extensive modifications to SPF and have packaged over 50 patents into a process they call Quick Plastic Forming (QPF). Much of the know-how and process development has been directed to commercially produce QPF aluminum body panels such as lift gates and tail gates, replacing heavier steel and fabricated body shapes. This paper describes GM's preproduction studies to produce prototype magnesium body panels using QPF, including the alloy, the ultra-fine grained metallurgy (1-10 μm), the temperature range (~ 450 oC) and the blow molding (procedures, equipment and tooling) that can economically fabricate a magnesium sheet into a complex automotive shape.

New Applications of Magnesium Die castings in Powertrain Applications in the Porsche Panamera Engine

Klaus Decking, Georg Fischer Automotive, Austria

Magnesium usage in Powertrain Applications was so far limited due to the characteristics of Magnesium Alloys to bedplates, cylinder covers, gearbox housings and in one case engine blocs. Due to the development of new alloys the applications could be extended with the new Porsche Panamera V6 and V8 engines to oil cover modules and chain covers.

In addition to the weight savings in comparison to Aluminium due to less specific weight of Magnesium of around 30% another additional 15% (so a total of 45%) of weight could be saved due to the possibility to optimise the design by reducing wall thickness because of Magnesium's superior casting characteristics.

Further to the weight savings, costs could be reduced by 0,2 € for every kg saved. So using Magnesium is not only reducing weight but also reducing costs!

Due to the early decision in the design phase to use Magnesium all Magnesium related major issues such as corrosion, porosity, recycling, cast ability, etc. were solved while keeping the same or superior performance of the parts

All this is underlined with the example of the Porsche Panamera parts

Die-casting magnesium with a dry powder lubrication system

Dr Chris Harris, Twin City Die Castings Company, USA

Lubricants applied to the tool in high pressure die casting aid the release of the part, minimize soldering and extend the life of the die through better running conditions. However, traditional lubricants are water-based, notoriously wasteful, sometimes have special disposal requirements, are costly and raise safety concerns due to the proximity of water to molten metal. There exists another lubricant which is both novel in formulation and application. It is a dry powder applied electrostatically to the surface of the tool. Runs of this dry powder lubricant during the die casting of a magnesium bicycle fork have shown the powder to be very cost effective, at no detriment to part quality. In addition there are significant safety improvements from decreasing exposure of the molten metal to water and great environmental benefits due to less waste during application. This paper details the trials and implementation of this new system at TCDC Inc.

Magnesium Scrap Recycling into Hot Metal Desulphurization Agents

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As is known, magnesium in dispersed form is, at present, part of majority of blast-furnace hot metal desulphurization agents. Based on the analysis of physico-chemical and processing characteristics of secondary magnesium alloys that are formed by magnesium scrap remelting and on practical experience in scrap recycling into marketable product, a rational scheme for the production of desulphurization agent of optimum composition is substantiated. Basic advantages of magnesium agents in the shape of granules, i.e. spherical particles of definite sizes have been demonstrated. The influence is examined of such elements as aluminum, silicon, calcium and rare-earth metals on basic properties of desulphurization agents from secondary magnesium alloys.

Filled robust aluminium tubes for all casting processes, especially magnesium casting

Dipl.-Ing. Frank Heppes, Drahtzug Stein combicore GmbH & Co. KG, Germany

New technologies require new concepts of cooling and a consequent lightweight construction and build. With the filled and very robust combicore tubes of aluminium you realize channels for oil, water and cooling in different casting parts. The alloy of these cores is especially dedicated for magnesium. Typical applications are found in automotive industry, e.g. gear boxes or motor blocks. The combicore tube follows the geometry of the structural element, so you can realize a form follows the function with a great saving of material. At the same time the casted part is clearly lighter. Inserted combicore cores also allow fewer costs in the later continuous working process. So do lighter cars need less fuel. In addition different external function could be integrated into the building element itself. In this way internal arranged lines will be protected of external influences and damage.

Combicore even allows you to insert aluminium tubes with a very small wall thickness. They resist a casting pressure over 1.000 bars.

Filled combicore tubes are proven and tested in several practical applications. They preserve our environment and natural resources. The innovative manufacturing method combines successfully the wire treatment technologies with the welding practice. In the production the diameter of the filled tubes are reduced. During this step the filling will be compacted and stabilized. Afterwards the tubes are bended into the required shape and pressed to get a plain form, if necessary.

After the casting process the ecological filling will be removed out of the tube within working time. You can use this material for other purposes or for recycling. A conspicuous finishing of the casted parts with high abrasion of tools is not necessary. The recycling of degraded material is easy.

At the same time the inserted aluminium tubes nearly have the same heat expansion like the magnesium alloy. Hence you realize a very good heat transmission and an excellent cooling effect.

Effect of Microalloying with Ca, Sr and Ce on the Interpass (static) Softening Occurring during Hot Rolling of AZ31 Magnesium Alloy

Stephen Yue, McGill University, Canada

In order to investigate the possible improvement on the control of grain size during hot rolling for the commonly used AZ31 alloy by a microalloying approach, small amounts of Ca, Sr and Ce were added into commercial AZ31 alloy. A two-hit compression testing was used for quantitative examination of the interpass softening as occurring during hot rolling process using as-cast microalloyed and base AZ31 alloys. The microstructure evaluation during the compression testing for the two alloys was compared. The results show that microalloying has an effect on decrease of interpass softening by retarding the grain growth of the recrystallized grains due to an obvious increase in volume fraction of thermally stable second particles. This microalloying approach combined with hot rolling schedule design could generate a favorable and uniform grain size, as demonstrated by the microstructure observation for microalloyed AZ31 sheet materials.

New Heat-Resistant Wrought Magnesium Alloys with LPSO Structure

Yoshihito Kawamura, Kumamoto University, Japan

New heat-resistant wrought Mg-M-RE alloys that are duplexes of α -Mg phase and a novel phase with a long period stacking ordered (LPSO) structure, have been developed in Japan. The M element is Co, Ni, Cu, Zn or Al, and the RE (rare earth) element is limited to Y, Gd, Tb, Dy, Ho, Er or Tm. Four kinds of LPSO structure found in these alloys are 10H, 18R, 14H and 24R, in which the M and RE elements are enriched in two atomic layers on basal planes at intervals of 5, 6, 7, and 8, respectively. These LPSO-containing alloys, which are drastically strengthened by plastic deformation at high temperature, have excellent yield strengths ranging from 350 to 510 MPa at RT, and from 230 to 310 MPa at 523 K. These excellent mechanical properties are originated from the LPSO phase within which kink bands are formed through hot working. This kinking can be a new concept for strengthening of metals. A production method for large-scale wrought LPSO Mg-M-RE alloys has been developed in Japan. Rods and pipes with a diameter of 60 mm, and sheets with a width of 150 mm are currently available as prototypes.