2005 Abstracts

"Opportunities and Challenges of China's Magnesium Industry"
Shi Wenfang; China Magnesium Productivity Promotion Center and Li Wensheng; Huayuan Magnesium Group
With the invention of Pidgeon Process and the increasing demand in the World War II, the magnesium industry developed quickly and the Pidgeon Process became the main Mg production Process adopted by most countries. China magnesium industry gained fast development and enlarged her world market share and strengthened R&D force with lower cost comparing with western countries. Our burden of natural resources and the environment protection issues along with international trade tariffs are our conjunctures we must face. At the same time, we are also facing the biggest opportunities that China has ever met. The Pidgeon Process gained great success in China but that is not enough for China to overcome the conjunctures and grasp the opportunities before us. New Pidgeon Process must be adopted and promoted to ensure that China has the ability to take the huge market created by automotives and electronic products and the ability to overcome the conjunctures caused by natural resources and environment issues. With developed New Pidgeon Process, China will make greater contribution to the world magnesium industry.

"The Effects of Heat Treatment and Alloying Elements on the Properties of Elektron 21 Alloy"
Paul Lyon, Ismet Syed, Tim Wilks; Magnesium Elektron UK
Elektron 21 is a Mg-RE-Zn-Zr alloy designed for Aerospace and Specialty Applications. The alloy is capable of operating up to approximately 200°C (400°F). To achieve successful applications, Elektron 21 has had to show not only good mechanical properties but also ease of castability and good corrosion performance. When developing the alloy, the effect of the Neodymium and Gadolinium Rare Earth constituents, as well as Zinc were optimized to achieve these requisite alloy characteristics. The level of Rare Earth component and, more importantly Zinc content, must be limited and controlled to achieve good and consistent corrosion performance. Changes in the Zinc and Rare Earth levels affect the age hardening response. Control of individual Rare Earth components such as Neodymium and Gadolinium also influences castability. Finally, the effects of heat treatment variables were assessed in relation to corrosion performance.

"Uplift China's Pidgeon Magnesium Reduction Procesing Level and Develop Recycling Economy"
Meng Shukun, Xu He, Wu Xiuming, Xie Shuisheng, and Han Wei; China Magnesium Association
The article releases the output, export volume and consumption of China's primary magnesium and magnesium alloy and analyzes the economic operation situation of the magnesium industry. The article mainly introduces the improvement of the equipment level in China's Pidgeon process of magnesium making; energy structure adjustment and tiered energy utilization; environmental protection and harnessing; mechanization and automatic controlin production process; new-type of reduction furnace and comprehensive utilization of the wastes. It points out that China's magnesium industry is embarking on an environmentally-friendly and highly-efficient recycling economy road with uplifted level, reduced consumption and conserved energy.

"Future Aspects of Magnesium Sheet Materials Using a New Production Technology"
Bernhard Engl; MgF Magnesium Flachprodukte GmbH
Magnesium has been added to the materials expertise on offer from ThyssenKrupp Stahl AG. It is planned to make flat magnesium strip and sheet products at competitive prices with the aid of casting-rolling technology. Strips in a width of 700 mm and thicknesses ranging from 4.5 to 7 mm have already been produced in weights of over four tonnes on a pilot line. Industrial rolling trials have succeeded in producing sheets in widths up to 2000 mm and a minimum thickness of 0.55 mm. Strips are, in the meantime, also being wound into coils on the pilot line for downstream processing. The mechanical properties concur well with the state of the art. By raising the temperature, it is possible to increase the formability considerably.

“Injection Molding of Magnesium Alloys – Present Challenges and Future Opportunities”
Frank Czerwinski; Husky Injection Molding Systems, Ltd.
The application of semisolid processing for net-shape forming of magnesium alloys is presented with a particular attention being paid to emerging techniques of injection molding. The key requirements imposed on basic and auxiliary hardware, alloy chemistry, feedstock morphology and processing parameters are characterized. It is shown that modern thixosystems represent a universal and multitask tool capable of implementing a variety of processing techniques based on both the thixo and rheo-routes, which result in unique microstructures and properties. In addition to conventional methods, novel and unique opportunities in processing of magnesium alloys are suggested along with future development directions.

“Development and Application of Luster Anodizing Technology on Magnesium Products”
Kazuhito Nishinaka, Tadao Ito, Masahiro Akimoto; DENKAHIMAKU Inc.
To this day, various processes of magnesium anodizing has been developed and applied but much of it has resulted in obscure film on surfaces. By considering a number of processing conditions, a successful new finishment technology in which the degree of surface luster of magnesium alloy products are taken into consideration was developed and has been applied to IT product parts. This environmentally friendly anodizing technology; with no use of heavy metal elements and is also non-pollutant during recycling process; is especially suited for use on Mg products produced by press forming such as colorful outer body shell of electrical devices like laptop computers, cellular phones, digital video cameras and digital cameras etc. With film thickness of 5-10μ , luster degree of 83% at measurement angle of 85 degrees was achieved which is 6 times what is possible with current technology. Also, because the process of surface priming can be deleted, procedure is shortened drastically which leads to cost reduction. Corrosion resistance, dimension precision and other characteristics will also be discussed.

“The New BMW Inline Six-Cylinder Composite Mg/Al Crankcase”
Andreas Fischerworring-Bunk, Christian Landerl, Andreas Fent, Johann Wolf; BMW
BMW’s new inline six.cylinder spark –ignition engine sets new standards in specific power, weight and fuel consumption. The fundamentally new design is based on the latest technologies, such as an electric coolant pump, a further development od BMW’s VALVETRONIC variable valve timing and as additional major innovation, the composite magnesium-aluminium crankcase. The engine will be installed in virtually all BMW vehicles and used worldwide. The engine crankcase design concept, the alloy development program and the relevant process aspects will be addressed. Critical for the development was to balance in the Mg-alloy the mechanical properties on one side and castability on the other side; with each of the properties having a minimum requirement to comply with the design and manufacturing concerns. Due to the compound concept chosen, the interface posed challenges to both the production and design. A set of novel techniques has been used to cope with these tasks.

“The BMW Magnesium-Aluminium Crankcase – A Challenge for State-of-the-Art Light Metal Casing”
Johann Wolf, Wolfram Wagener; BMW
BMW is presenting an inline six-cylinder engine that is truly revolutionary in every respect. This new spark-ignition engine is the realization of the BMW concept of efficient dynamics at the very highest technological level. For the first time in the history of modern engine design, a water-cooled crankcase is manufactured by magnesium casting for the mass production. This impressive use of composite magnesium/aluminium technology is a milestone in engine construction and took place at the light-metal foundry of the BMW Landshut Plant. This report gives a close summary about process-development, the constructive structure, and the details of the manufacturing processes.

“Lifecycle Assessment of Magnesium Component Supply Chain”
Ambakavanar Tharumarajah, Paul Koltun; CSIRO Manufacturing & Infrastucture Technology
The development of magnesium applications for automotive industries has received significant attention due to its light-weight and consequent potential to reduce fuel consumption and greenhouse gas (GHG) emissions at the use stage of cars. However, this apparent reduction may be off set by the higher GHG emissions in

manufacturing of magnesium components compared to aluminium and steel equivalents. In order to determine the actual environmental advantage or otherwise of magnesium components requires a lifecycle assessment of its impact along the entire component supply chain, from ingot production, casting, use and final disposal and recycling. This paper reports on such an assessment for a magnesium engine block manufactured using 70% primary magnesium and the rest secondary, and sulphur hexafluoride (SF_6) as the cover gas for melting in the casting stage. The resulting impact is examined for its sensitivity to increased use of secondary magnesium and substitution of SF_6 with AM-Cover cover gas that has around 7% of the global warming potential. A comparison of the GHG impact of the nominal and environmentally improved system with equivalent engine blocks made from aluminium and steel indicates the competitive environmental performance of the magnesium engine block supply chain.

"Recycling of Magnesium Chips and Sludge – A Solution Serving the Magnesium Die Casting Industry"
Guenter Franke; Hydro Magnesium
Increasing usage of Magnesium alloys and especially new applications with creep resistant alloys in the car industry in Europe will create huge amount of chips in the future. This will start in 2005 and change the situation in the european Mg Die Casting industry in terms of handling this residues in a safe and economic way. In addition increasing recycling capacities will create more Mg sludge. Both chips and sludge have to be treated in a safe, environmental friendly and economical way to secure the futur of Mg growth. Hydro Magnesium and partners have developed new processes to treat this Mg residues and plan to set up a facility in Germany to serve the European Mg Die Casting industry. Concept, processes and markets are described in this paper.

"Cost Effective Solutions for Handling Magnesium Alloys in Die Casting Plants"
Jan Bolstad, Simon Cashion, Christian Kettler, Gordon Dunlop; Advanced Magnesium Technologies Pty Ltd., Peter Neckermann; Hindenlang GmbH, Dag Baekkedal; Nordiske Industriovner A/S
Metal losses and the creation of returns for recycling at several stages in a diecasting operation add significantly to the cost of magnesium diecastings. Careful flow sheet analysis for a particular operation enables identification of areas of excessive cost where improvements can be made. Melt losses and the cost of recycling of in-plant returns can be significantly reduced by introduction of the new melting device, the AM-converter. This equipment enables: rapid melting of ingot; direct re-processing of returns in-cell; significantly reduced melt losses; virtual elimination of sludge formation; increase of furnace capacity; extension of crucible life; and reduction of maintenance costs. This leads to considerable savings in operational costs for diecasting operations.

"Designing for Robust Screw Joints in Magnesium"
Chase Brill, Jordon Mackey, Jason Surber; ATF, Inc., Frank Schlossner, EJOT GmbH & Co. KG
Historically, threaded steel fasteners driven into tapped holes have been a common joining method for magnesium. Not only does this involve costly drilling and tapping operations, but it can also lead to long-term joint instability. Several fastener designs currently exist addressing these issues in different ways. Various thread-forming fasteners made of steel have been designed which reduce in-place costs by up to 40%; However, the load retention for steel in magnesium remains a concern. Aluminum machine screws have been developed which improve load retention but have limited load-carrying ability and increase joint costs significantly. ATF and EJOT will present comparison testing including torque analysis, clamp load at raised temperature, and uniaxial pull-out force. As a conclusion, ATF and EJOT will provide recommendations to design a robust screw joint in magnesium.

"Research Programme: Extension of the Range of Applications for Magnesium Alloys"
Petra Maier, Karl Ulrich Kainer; GKSS Forschungszentrum Geesthacht GmbH
A new Priority Programme of the German Research Foundation entitled "Extension the Range of Applications for Magnesium Alloys" (InnoMaTec) has started April 2004. This six year programme is founded with 3.6 Mio € for the first two years. It consists of 26 projects from 16 universities and research institutes dealing with following topics:

- Systematic investigations on influence of micro alloying elements in common and new alloys
- Micro structural evolution during solidification and processing and by thermo-mechanical treatments
- Relationship between microstructure and processing parameters in accordance to process and microstructure modelling, fracture mechanics
- Modelling of materials properties for latter use in modelling of components
- Development of innovative joining technologies for monolithic and dissimilar materials
- Systematic investigations on corrosion behaviour of new alloys
- Development of suitable surface coatings

The presentation gives an overview on aim, targets, structure and projects within this research programme.

"The Audi Hybrid Magnesium Cylinder Block – A Challenge for Development and Production"
J. Böhme, W. Schneider, J. Doerr, A. Rothe, C. Haberling; Audi AG, S. Schumann, T. Rudolph; VW Group Research, K.D. Becker, D. Strümpfler, U. Bischoff; VW
To use also magnesium in engines subject to extreme loads if special detail design solutions and new creep-resistant alloys are necessary. To compensate the shortcomings of magnesium, AUDI developed a new crankcase concept in which the magnesium structure is reinforced by targeted local material engineering in critical areas. The result of this development is a compact, multi-functional cylinder insert made of aluminium and incorporated into the magnesium block by a pressure die-casting process. It combines the typical functions needed in the engine block, namely cylinder wall, threads for the mounting of the cylinder head, threads for the mounting of the main bearing caps and water jacket (for engine cooling). The special feature of this engineering concept is the fact that both open-deck as well as closed-deck engine blocks for high peak pressures can be produced by the die-casting method. So far this advantage has only been available with sand cast or gravity cast engine blocks. The simulation of key problems, the relaxation test results of bolt connections of first prototypes as well as the HPDC-process development will be explained in detail.

"Design and Development of a High Pressure Die FEC (Front End Carrier) for Exterior Automotive Applications"
Andrew Tippings, Tony Lawson; Meridian Technologies Inc.
Traditionally vehicle body structure front end modules have been either fabricated pressed steel assemblies, fabricated pressed aluminium assemblies or plastic / steel hybrids. Magnesium die cast technical solutions are now in series production which are either welded at the "BIW" stage or bolted in the body at the exterior trim stages of production. Magnesium has been chosen as the preferred solution over alternative technologies such as steel or aluminium fabrications and plastic / steel hybrids because of weight saving, integration opportunities (reduced complexity / costs), superior structural performance (contribution to BIW performance) and geometric stability (fit and finish) advantages. The latest "second generation design" of bolt in front end carriers (FEC's) also take advantage of further integration opportunities which have not been implemented to this extent before. The single piece casting technique has shown many advantages in the location of major visual components in the front of the vehicle i.e. headlamps, grille, and bumper trim cover and thus relationship / gaps between them via 4 way and 2 way location features. An FEC acts as a "backbone" for these and other parts and eliminates tolerance stacks associated with fabricated steel / aluminium assemblies. This advantage has become an increasing priority of recent times because of the customer perception of craftsmanship. This paper discusses the design and development of the front end components to meet structural, corrosion and visual requirements.

"Exterior and Interior Applications"
Leopold Postlmayr, Georg Fischer
In this paper, the author presents the steps in realizing internal and external applications of thin-walled magnesium structural parts shown on three parts integrated in the new DaimlerChrysler SLK: A tank barrier and a seat frame with a partially visible surface in the interior, as well as the rear window frame on the exterior. Beginning with the Porsche convertible top, our company started manufacturing exterior applications in the 90s. Georg Fischer in Altenmarkt has continued producing the rear window frame used in the DaimlerChrysler SLK. The current tank barrier achievement represents the next evolutionary step in lightweight applications.

The special design requirements pertaining to visibility, crash and corrosion have been considered. Such tools as filling and solidification simulations were used to achieve the challenging design und production targets. The evaluation of proper casting, machining, coating and quality concepts are also presented in this paper.