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2016 Presentations

Thursday, January 21st

Market Outlook for Ferrite, Rare Earth and Other Permanent Magnets: 2015 to 2025 …..1

Both the producers and users of magnets have experienced 5 years of uncertainty in materials supply, wide price swings, and development of incremental improvements in magnetic properties. It's been 34 years since the discovery of NdFeB and 24 years since the discovery of SmFeN. Extensive, funded research has been unsuccessful in identifying commercially interesting improved or replacement materials. Meanwhile, developing applications are set to consume dramatically increased quantities of permanent and soft magnet material. We'll dust off the crystal ball and forecast magnet usage in several industries, and identify problem areas and opportunities.

Steve Constantinides, Director of Technology – Arnold Magnetic Technologies

What Licensing Means (and Doesn't Mean) for Sintered NdFeB Manufacturers and Users…..44

The ITC case from Hitachi was supposed to clarify the licensing situation for producers and users, but instead has generated more opposition and confusion. Looking carefully at what licensees can, and cannot do, doesn't help matters because big sections of Hitachi's IP portfolio are not available to licensees. To assist manufacturers and users in understanding where the IP risks lie, MagnetoDynamics has been working with manufacturers to analyze their processes, identify where these risks might be, and then how to avoid them. The presentation summarizes the process, the risks and discusses some of the very strange patenting methodologies that are now being used.

James Bell, Consultant – MagnetoDynamics

Challenges & Opportunities of Ningbo Magnet Industry: Past, Present and Future…..61

In China, more than 50 percent of magnets were produced in Ningbo; this city has more than 60 percent of the magnet export market share every year. It produces and only produces the finest quality magnet around the world. Having said that, every entity has came across difficulties. Some of them overcome the challenges, some were eliminated

by the market. Know more about us, the problem we've coped, the challenge we are facing. And what Newland Magnetics did, as an example of magnet manufacturers, transformed to adapt current market.

Frank Wang, Founder & CEO – Newland Magnet Industrial Co., Ltd.

The Choice of Magnet Maybe Half the Problem – Assembling it into Your Device is the Bigger Half…..70

Applications for powerful rare earth magnet assemblies are vast and continue to grow. As it is not possible to optimize magnetic design by magnetizing final assemblies, assemblies must be built with magnetized magnets. Building these assemblies with such high strength magnets is a complicated and physically dangerous challenge. Approaching the puzzle requires planning and thorough consideration. Magnets with large, powerful magnetic fields can blind side an assembly worker in an instant. Discover how intelligent assembly design ensures the safety of those working with the assembly, and also the optimal performance in the final application.

James Tyler, Head of Sales – TyTekBakker Magnetics

Magnetizing Considerations for Motor Design…..80

For several reasons magnetization closer to the end of the assembly process is often more desirable when manufacturing motors. In many cases the desired magnetization can be imparted to any motor design. In some cases however, physical limitations of the magnetizing process should be considered concurrent with critical motor design decisions. This is particularly true for IPM rotor designs and for isotropic magnet materials. This presentation will discuss specification of magnetic assemblies for magnetization, capabilities and limitations of magnetizing equipment, and case studies in which incorporating magnetization into the motor design process can result in superior motor cost-performance results.

David Miller, President – Magnetic Instrumentation

Comparison of Permanent Magnets for Different Applications…..100

Permanent magnets have been widely used in many industries. This presentation will focus on the criteria to choose and specify permanent magnets (NdFeB, SmCo, Alnico and hard ferrite) for different applications, including magnetic properties, mechanical strength, temperature stability, corrosion resistance, surface protection options, mechanical tolerance, adhesive options for assemblies, and the considerations of thermal expansion coefficient during the design stage. The pros and cons of each type of permanent magnets for different applications and the importance of soft magnetic return path in magnet assemblies will also be discussed.

Dr. Jinfang Liu, Chief Operating Officer – Electron Energy Corp.

The Design of a Permanent Magnet Motor for Direct Drive Fan Application…..122

This presentation will be a case study that will investigate the designs of an outer rotation style permanent magnet brushless motor and an inner rotation style permanent magnet brushless motor. This motor would be used as a direct drive motor on a large fan application. This application is a very high inertia, low speed type of application and would have a high torque since it is direct drive. The two types of designs will be compared by investigating the volume of the three main components of magnet material, copper and iron.

Lowell Christensen, Vice President of Engineering – TruTech Specialty Motors

Cost Reduction Rhrough Dy-Free and Low-HRE Grades…..127

Post-2011 Rare Earth crisis, Heavy Rare Earths (HRE), Dysprosium and Terbium, were identified to be the most severe cost contributors in high coercivity, high energy product material grades. They accounted for up to 90 percent of the total cost. Major corporations from the automotive and energy industries demanded solutions, ranging from reduced Neo/HRE designs to the elimination of Neo/HRE altogether. Since 2012, following on the Government 863 Initiative to reduce HRE content, Yunsheng extended its efforts to achieve Dy-free grades for low coercivity materials (M and H) and low-HRE material grades for high coercivity grades (SH, UH, EH and AH).

John Ebert, Business Manager, Yunsheng USA

 **Tailoring of Pole Shapes of Multipolar Injection Molded Permanent Magnets - UPDATED PDF…..136**

For injection molded magnets pole shape can have an essential impact on their final performance in magnetic sensor applications, electrical machines or other. In a magnetic path sensor e.g. the choice of the right pole shape can have a large influence on the grade of its linearity and finally on its costs. The presentation will first show the physical principles how magnetic poles originate magnetic fields around a permanent magnet, and which aspects have to be considered to design different pole shapes. There will then be presented various sorts of magnets as well as assemblies for their manufacturing to get advantageous results for different situations and customer demands. There will also be shown how to design such systems by FEM, which is usually a sequence of several simulation steps, starting with the manufacturing tools and ending with the magnets application.

Thomas Schliesch, Head of Research & Development – Max Baermann GmbH

Thermal Aging of NdFeB Magnetic Powder in Hydrogen - UPDATED PDF…..151

Injection molded (IM) NdFeB magnets are of interest to improve traction motor efficiency, cost, and manufacturability. However, IM NdFeB magnets show substantial thermal aging losses at motor operating temperatures when exposed to automatic transmission fluid (ATF) used as a lubricant and cooling medium. The intrinsic coercivity Hci of NdFeB IM magnets degrades by up to 18 percent when aged 1000 hrs in ATF at 150°C. Aging studies of NdFeB powders reveal Nd2Fe14B crystal lattice expansion in both ATF and H2, implicating hydrogen dissociated from the ATF and diffused into the Nd2Fe14B phase as the probable mechanism of coercivity loss.

Margarita Thompson, GM Research and Development Center

Integrating Magnetic Field Mapping, Crack Detection and Coordinates Measurement…..162

The quality control of permanent magnets often requires the accurate mapping of the magnetic field around the magnet under test, combined with the material inhomogeneity test and crack detection in the magnetized and even non-magnetized parts. Such tests require an accurate positioning of measurement probes with respect to the magnet coordinate system. These requirements can be achieved by combining in a single device the features of a magnetic mapper, the eddy-current measurements and a coordinate measurement machine. The new solutions are available for an easy and smart interchangeability of 3-axis Hall probes for magnetic field mapping, eddy-current probes for crack detection, sliding probes for in-contact magnetic field measurement, touch stylus for coordinate measurements and other specialized measurement probes.

Sasa Spasic, CEO, SENIS AG

Coating Integrity Following Thermal Demagnetization of Rare-Earth Permanent Magnets – A Reuse Strategy…..176

Recycling end-of-life rare-earth permanent magnets is becoming an important supply path of raw material in the production of said magnets. Direct reuse of end-of-life rare-earth permanent magnets is potentially a more cost-effective recycling-path, since it bypasses all the production steps necessary in traditional recycling. In this presentation we present a reuse strategy for neodymium-iron-boron magnets that relies on thermal demagnetization of the magnets to be reused. Magnets with different commercial protective coating are recycled, and the chemical and mechanical properties of the coatings, as well as their magnetic properties are measured and compared experimentally in order to evaluate any lifetime changes.

Stig Högberg, Ph.D. Researcher, Department of Electrical Engineering
Technical University of Denmark (DTU)

Bridging the Gap Between Open-Loop and Closed-Loop Hysteresis Measurement System for Permanent Magnets…..218

It is becoming accepted that open-loop and closed-loop yield the same results for the key parameters of a hysteresis trace: Br; HcB, HcJ and BHmax. An international round-robin organized by the IEC comparing pulsed field magnetometers and conventional systems with electromagnets confirmed this [TR 62331]. A comparison of both systems will be given. Small differences between the open-loop and closed-loop measurement systems can be observed near the knee point. In our continued effort of the product development of the HyMPulse, the first steps were taken to bridge that gap.

Dr. Luc Van Bockstal, Technical Director – Metis Instruments

Bonded Magnets 2016: Current Status and Future Developments…..228

The global production of rare earth based bonded magnets is estimated to be $750 million in 2015. When the production of ferrite based bonded magnets is included the bonded magnet segment of permanent magnets is a very significant but often overlooked class of permanent magnet materials. In this presentation the main types of current materials and

processing steps will be reviewed together with the latest developments in materials and novel manufacturing technologies e.g. additive manufacturing (3D printing). In addition the major applications and market drivers will be discussed.

Dr. John Ormerod, Senior Technology Advisor – Magnet Applications, Inc.

Status of Soft Magnetic Composites in Electro Magnetic Applications…..252

Use of iron powder in inductors and filters has been in existence for a longtime. The advancements in the purity of atomized iron powder and higher density technologies prompted the development of iron powder with insulated coatings for replacing lamination steels in certain AC applications. These are non-sintered parts, just pressed and cured. The net shape green process of powder metallurgy techniques allows complex shapes to be formed with very little or no machining. Sintered iron and iron-Si powders are used widely in automotive DC applications. This presentation details the current state of the technology in non-sintered soft magnetic composites. High resistive coatings developed recently allow these products to be competitive with Fe-Si lamination steels in high frequency reactor cores of hybrid vehicles.

Sim Narasimhan – P2P Technologies

Friday, January 22nd

What's in Store for the Global Magnet Industry?…..282

The panel will discuss and debate the following key questions: (1) Considering the current (and complex) legal battle between the Chinese and Hitachi, is there anything positive we can expect? Who might be the winners and losers? (2) How can magnet buyers and sellers plan for future price movements for NdFeB magnet prices? (3) Many institutions have tried to develop a "rare earth free" replacement for NdFeB magnets. Can we expect a breakthrough technology in the magnet industry during the next few years? (4) Current Chinese NdFeB magnet production capacity is excessive. Is there any possibility for future Chinese industry consolidation?

Moderator: Walt Benecki, President – Walter T. Benecki LLC
Panelists: Dr. John Ormerod, Sr. Technology Advisor -Magnet Applications Inc.
Steve Constantinides, Director of Technology – Arnold Magnetic Technologies Inc.
Yutaka Yoshida, Sr. Manager – Technical Support – Daido Steel (America), Inc.

Recent Developments in High Performance NdFeB Magnets and Bonded Rare-Earth Magnets…..294

In this presentation, an overview of our development, improvement, and applications of hot-deformed NdFeB magnets and rare earth bonded magnets is presented. Taking advantage of nanometer-size microstructures and a unique grain orientation mechanism, hot-deformed magnets with coercivities over 560 kA/m at 150°C are now available without the addition of heavy rare earths. In addition to radially oriented rings, axially oriented plates have been developed for applications such as HEV traction motors. For bonded magnets, the status of NdFeB and SmFeN bonded magnets is given, including our special molding techniques for high-reliability automotive applications. In addition, our new PLP (press-less process) sintered NdFeB will be introduced.

Yutaka Yoshida, Sr. Manager – Technical Support - Daido Steel (America), Inc.

The Economic Manufacturability of Rotor Magnets and Assemblies…..314

More often than not, we have seen specifications on drawings are very tight in terms of dimensional tolerance, geometric tolerance, magnetic properties, magnetic orientation, coating thickness, radius, angle, tight tolerance on theoretical point and redundant dimensions which interfere to each other etc. 7.25 million pieces of rotor magnet have made with inner diameter tolerance range of 0.0005″ on NdFeB ring but most magnets don't have to have this kind of accuracy. Attend this presentation to learn the guidelines on choosing proper specifications from the magnet manufacturing point of view.

David Dai, Vice President – Pacific PAC Technologies, Inc.

Application of Magnetic Measurement Technology in Development and Production of Electromagnetic Actuators…..323

In the 20th century electromagnetic measurement technology was mainly used for detecting magnetic fields in air and for determining the magnetic properties of ferromagnetic materials. Recently, a new field for magnetic measurements has been established, addressing complex electromagnetic actuator systems. The innovation in this field is based on the utilization of the sensor function of the integrated actuation coil. This

allows non-destructive testing as well as condition monitoring of electromagnetic systems during production and inside the application. The presentation will show potential application scenarios of magnetic measurement technology.

Andrey Gadyuchko, Magnetic Measurement – Kendrion

Recovering Rare Earths from End-of-Life Magnets…..364

In an effort to address likely future rare earth shortages, several recycling and reuse processes for waste streams containing rare earths have been developed. However, NdFeB magnets from motors and generators are currently not recycled. Major barriers towards feasible recycling are the lack of knowledge on the fate of rare earth magnets and the lack of a commercially feasible technology to recover rare earths from materials mixtures present in end-of-life products. This presentation will describe our successes addressing
these challenges, resulting in a recycling process with high recovery efficiencies up to 82 percent and excellent product purity (>99 percent).

Marion H. Emmert, PhD, Assistant Professor, Departments of Chemistry & Biochemistry, Chemical & Mechanical Engineering – Worcester Polytechnic Institute

Quality Control of PM Rotor Systems by 3D Hall and Innovative Magneto-Optics…..384

Accelerated by enhancements of electric mobility, testing of electric motors has become of increasing importance in the automotive industry. Due to inhomogeneous magnetic fields an inaccurate PM rotor makes an electric motor inefficient and reduces the engine power directly. To this day, a fast and precise rotor measuring device for 100 % quality control is not available. Matesy has developed a rotor measuring station based on a 3 axis Hall-sensor for 3D field analysis, magneto-optical sensor module for fast and high-resolution magnetic field measurement and a distance sensor for simultaneous geometry determination. Due to trigger frequencies above 5 kHz the set-up provides enormous speed advantages with high lateral resolution. Based on high measurement speeds a 100 percent inline inspection of PM rotors is now possible.

Matthias Schmidt, Research Associate - MATESY GmbH

High Temperature First-Order-Reversal-Curve (FORC) Study Of Ferrite-Based Magnetic Materials…..400

First-order-reversal-curves (FORC) are an elegant, nondestructive tool for characterizing the magnetic properties of materials comprised of fine (micron- or nano-scale) magnetic particles. FORC measurements and analysis have long been the standard protocol utilized by geophysicists and earth and planetary scientists investigating the magnetic properties of rocks, soils and sediments because FORC can distinguish between single-domain, multi-domain and pseudo single-domain behavior, and because it can distinguish between different magnetic mineral species. More recently, FORC has been applied to a wider array of magnetic material systems because it yields information regarding magnetic interactions and coercivity distributions which cannot be obtained from measurements of a materials hysteresis loop alone. In this presentation we will discuss the FORC measurement and analysis technique and present high temperature FORC results for magnetically hard (e.g., BaSr, NdFeB) and soft (e.g., CoFe-SiO2, FeCo-based nanocrystalline nanocomposite) magnetic materials.

Brad Dodrill – Lake Shore Cryotronics
Paul Ohodnicki- National Energy Technology Laboratory

Advances in Powder Metal Technology for High-Performance Soft Magnetic Applications…..410

Traditional press and sinter powder metallurgy (P/M) is well suited for the production of soft magnetic materials due to its ability to produce net shape components from high-purity ferromagnetic alloys. New developments in P/M technology, like metal injection molding (MIM) and encapsulated ferromagnetic powder, add to the design flexibility that the metal powder process brings for producing cost-effective, high-complexity soft magnetic components. This paper discusses the type of parts that each variant of the technology addresses. Case studies that illustrate the benefits of powder metallurgy in component production will also be presented.

Matt Bulger, VP Technology – NetShape Technologies

 **Magnetic Ferrites Through Combustion Synthesis…..438**

Ferrites primarily comprise of iron based normal-inverse spinels, defect spinels and M-type magnetoplumbites. For two decades a unique combustion synthesis process has been developed and adapted to produce ferrites through solid-molten-solid synthesis. Thermal and microwave processing were used for grain boundary density, microstructure and shape control. Ferrites using these processes can be produced to a high purity, inexpensively and having unique properties. Ferrites synthesized through this method were compared to ferrites produced via conventional solid-state syntheses.

Dr. Ashvin Srivastava, CEO/Founder – PIM Group, LLC