Höganäs

POWDER NEWS

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Celebrations and new directions

As North American Höganäs celebrates 10 successful years in business, the company is focusing on expansion into new PM segments.

Over the last decade, North American Höganäs has established itself as a leader in PM technical development and won a 28% share of the US metal powder market.

In response to the tough economic climate, the company is looking beyond traditional PM applications to secure future growth.

Avinash Gore, the President & CEO of North American Höganäs, says: "For some time now we have been working to change the way we do business and reduce our dependence on the automotive sector. To achieve faster growth and better profitability, NAH is now focusing on segments outside the automotive industry."

Food fortification and preservation, life science, energy and environmental applications are among the new segments that are already yielding positive results.

Find out more about NAH's plans for the future on page 2.

NAH: the first 10 years

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Avinash Gore

Targeting growth in new PM segments

North American Höganäs (NAH) is looking beyond the automotive sector to secure growth by expanding into new PM applications.

Powder News asked **Avinash Gore,** President & CEO of North American Höganäs for his views on the current situation and what the future holds for the company.

How is NAH responding to the recession and decline in the automotive sector?

We are finding profitable growth niches in spite of the recession. Internally we are focusing on improving cost structures and asset utilization, and resizing our iron powder operations. Externally we are improving service levels to our customers and making the supply chain more cost effective. In order to increase the penetration of PM technology we are also working on market and application development with our key customers.

I am optimistic that the measures we have taken will mean we can be the fastest to respond to a more favorable business situation. However, for some time now we have been working to change the way we do business and reduce our dependence on the automotive sector. To achieve faster growth and better profitability, NAH is now focusing on segments outside the automotive industry.

Which areas are you focusing on?

There is a strong rise in products for the retail trade and we have also scored great successes in areas like food fortification, food preservation and life science. We see strong growth in these product areas, and very good prospects for continued growth. Another fast-growing area is small motors, which use our chromium and molybdenum materials.

Special alloys for the electronics industry are yet another success story. We have opened up new opportunities in the energy field with a fuel cell application. There is also growth in environment applications – a new water treatment product, for example, is now ready for launch after several years' development.

What are the prospects for food fortification?

This is an exciting growth area for iron powder. We are the only company in the world that can offer two types of product that meet the stringent global standards. One of them is electrolytic iron powder, and thanks to 30 years' application experience we now have the best product in the world. It's made in our Johnstown plant, and is used in baby foods on account of its high purity. The other product, NutraFine™ RS, is made in Niagara Falls. Kelloggs use it to fortify their cornflakes.

Food fortification with iron is a business area that is set to grow as more and more countries require or recommend iron enrichment in flour and other staple foods. Wheat-flour applications are the most usual, but iron enrichment of rice and noodles is on the way.

What role does the Tech Center (TC) play?

With a highly qualified staff of 14, two of them with doctorates, we offer unrivalled expertise. In fields like electrolytic powder, friction powder, water purification applications and stainless steel powder, the most know-how in the USA is right here in the Höganäs Group.

The focus of the TC has changed somewhat over the past few years, from research and analysis to application development. The TC also provides support in other areas, such as efficient handling of the technical requirements for producing Kobelco's products and helping to get new products such as Starmix® Boost into production quickly.

What does the Kobelco collaboration mean for NAH?

Kobelco found a good solution when they wanted to cease powder production in the US. They were willing and determined to keep on helping their customers even after they had left North America, and solved the problem by picking a partner – NAH – to take over responsibility for servicing their old customers.

The collaboration helps us to expand further among Japanese transplants in our region.

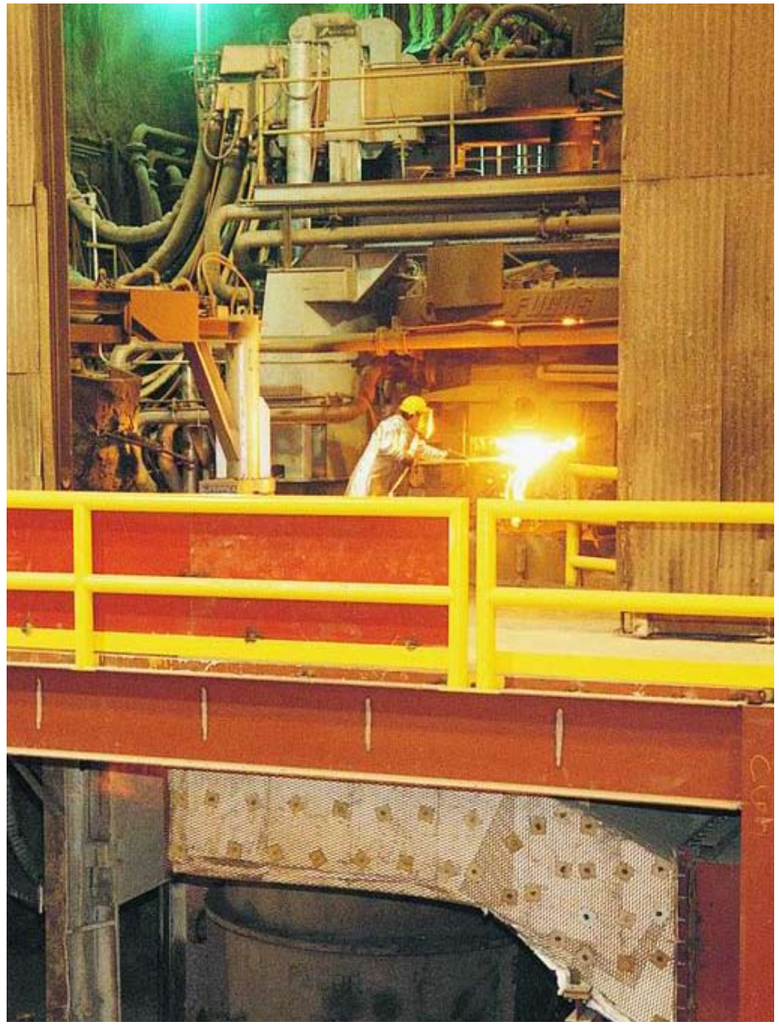
We are already providing technical support and other kinds of service to some Japanese manufacturers, but our collaboration with Kobelco will give a dramatic boost to this business. Closer relations with Kobelco open opportunities to make both parties stronger in other parts of the world, especially Asia.

What is the long-term aim of NAH?

The Höganäs Group is the world's leading manufacturer of metal powder, but here in North America we are still only number two. Our market share is around 28 percent, and our aim is to become number one in the huge North American market as well.

Will NAH be looking for acquisitions to drive growth?

There will of course be continued consolidation in the industry in the immediate future. As far as the Höganäs Group is concerned, we will seriously consider any opportunities that may arise. However, in my opinion, investment in new technologies and products in new customer segments is more attractive. Applications in energy, environment and food fortification look extremely promising.



NAH serves the North American market with locally-produced, high-quality products.

NAH PRODUCTION SITES

- **North American Höganäs** has three production sites and a blending station in the US. All facilities are triple-certified for quality (TS 16949), environment (ISO 14001) and safety (OHSAS 18001).
- ***Stony Creek***, the world's most integrated, state-of-the-art iron powder plant, produces water-atomized iron powder and pre-alloyed powders.
- **Johnstown** manufactures high-alloy powders, electrolytic iron powder and GLIDCOP®, a high-tensile copper alloy.
- **Niagara Falls** focuses on producing sponge-iron powder by its unique hydrogen reducing process for speciality applications such as friction and food fortification.
- **St. Mary's** is a mixing plant conveniently located in the heart of Pennsylvania's PM industry.

A decade serving the North American market

Ulf Holmqvist

Ralf Carlström

Ten years after it was founded, North American Höganäs (NAH) is well established as a leader in PM technical development and has gained a 28% share of the US metal powder market.

Powder News looks back at the challenges and achievements of NAH's first decade with two of the people who helped establish the company; **Ulf Holmqvist** (President 1999-2002) and **Ralf Carlström** (Sales Director 1999-2003).

Höganäs AB announced at the 1999 AGM that a North American operation was to be set up.

UH Things moved very fast after this. A sales office was established in Bethlehem, Pennsylvania a month later. We also started up the Tech Center, which was running by early 2000.

RC The early days were a fantastic time, being part of something that broke new ground. Our US colleagues really impressed us right from the start. They created a very positive atmosphere and were always ready to take on a challenge.

NAH acquired the Stony Creek steel mill site in February 2000. The Tech Center, sales and corporate management moved from Bethlehem to Stony Creek in January 2001.

UH We realized at an early stage that, as an American company, having local production was very important for market penetration, so that's why we quickly acquired a plant. It was vital to show our commitment to the market through this investment. We took over a bankrupt steel mill and rehired about 50 people in the first few months, who became the core of the production plant staff. Around 60 million dollars were invested to transform the site into a state-of-the-art atomized metal powder plant in just 18 months. This was accomplished on schedule, when the plant began production in October 2001. Pyron and its iron powder plant in Niagara Falls was acquired in April 2000.

RC Pyron broadened our locally produced range with specialty products such as friction solutions and nutrition additives. The conventional powder production of around 16,000 tons was transferred without problem from Niagara Falls to Stony Creek in just 3 months.

Adapting the growth strategy

RC Everything went smoothly setting up the company and Stony Creek, but market growth was not as expected. In fact, the market stopped growing around the time we started, so the timing was far from perfect.

UH Our original strategy was to grow through acquisitions, establish a strong technical presence and take a major share of new business. However, because of the market situation that new business never materialized. So we had to focus more on competing for existing business.

RC We took a market position fairly quickly and have grown linearly by around 2.5% a year. So I think we have been very successful in growth terms considering the market conditions.

UH The Tech Center was an important part of our strategy from the start. We wanted to bring in strong technical support so we could offer a comprehensive technical package with locally produced products, providing a total service that was unique in the US.

RC The expertise at the Tech Center helped us when we needed support to convert existing applications. We have invested continuously in the Tech Center and it has played a vital role in proving to customers that we could improve things for them. The acquisition of SCM Metal Products was completed in 2003.

UH The SCM acquisition involved two plants. The North Carolina plant focusing on copper was later sold, but the Johnstown plant in Pennsylvania added local production of high alloy powders for the North American market. North American Höganäs High Alloys, as it is now called, is the leading manufacturer of stainless steel powders in North America.

In 2008 NAH signed a joint venture agreement with Kobelco to take over its iron powder production in the US.

UH This agreement was indicative of the consolidation trend in the industry and has proved to be very successful for both parties.

RC Our experience over the years of converting products, such as transferring Pyron's products to Stony Creek, proved very useful, and the process of adopting Kobelco products went very well and according to schedule.

Lessons and achievements

UH At the start, Ralf and I were among a number of Swedes helping to start up the organization, but I think it is very satisfying to see that NAH has become a truly American company that is appreciated as a local producer. I think the Höganäs Group has learned a lot from establishing NAH. We were used to being a strong player, but in North America we were starting small and had to fight for our position and learn to compete in a tough market.

RC North American Höganäs has come a long way. It is a great achievement to have reached its strong market position with a 28% share, which shows the company's approach was right. NAH is recognized as the technical market leader and is now well positioned for growth.

Connecting with new materials

JUNE 30

A number of promising new materials are emerging to maintain the competitive edge of metal powder technology in connecting rod applications.

Metal powder technology provides a well-established solution for connecting rods via powder forging using the iron-copper-carbon material system.

"PM has a leading position in this application, but there has been an improvement in the competing technology, especially micro-alloyed carbon steels, which are displaying compressive yield strength and machinability properties similar to iron-copper-carbon," says Roland T. Warzel III, Manager Technical Service & Product Development at the North American Höganäs Tech Centre.

"Consequently, we have started to look for new materials to protect PM's position in the powder forging of connecting rods and have examined a wide range of alloying elements," he continues. "Chromium is a material we could take a close look at because Höganäs has built up such a good database on chrome alloys. We also studied the potential of manganese and vanadium."

Examining alternatives

A number of promising alternatives are examined in a technical paper for PowderMet 2009 entitled **New Materials for Powder Forged Connecting Rods** by Roland T. Warzel III, Ian Howe, Nagarjuna Nandivada, North American Höganäs and Sven Bengtsson, Anders Bergmark, Höganäs AB.

Powder forging produces parts with mechanical properties equal to wrought materials. As a near net-shape technology is involved, the parts require only minor secondary machining.

"Metal powder technology already offers a cost-efficient solution compared with wrought steel and we are looking for new materials that can give us a further cost advantage. It is also important that any new solution is a simple alloy system that can smoothly fit into customer's existing powder forging process," comments Roland.

> "What the research shows is that we have some promising material alternatives to investigate."

Finding the right balance

The main challenge is to find a material that offers the right balance of high fatigue strength, high yield strength and good machinability for connecting rod applications.

"Our report is an update on ongoing efforts to develop powders that increase the buckling resistance (yield strength) and fatigue strength while maintaining machinability and fracture split capability. If you go for superior yield strength, the resulting hardness can mean sacrifices on machinability, because high hardness makes machining more difficult. As always, the answer lies in the microstructure and we were looking for a specific structure similar to iron-copper-carbon."

Among the new material systems considered were alloy combinations of iron-vanadium, chromium-manganese-vanadium and chromium-manganese-copper as well as the Höganäs chromium alloy, Astaloy™ CrL. The majority of the investigated variants compared favourably with the iron-copper-carbon reference material in terms of compressive yield strength and hardness.

Summing up the test results, Roland says: "Three alloys stood out in particular. The iron-vanadium alloy proved to be the most promising in terms of achieving the right combination of good compressive yield strength and machinability. The Cr-Mn-V and Cr-Mn-Cu alloys were also promising. The latter alloy was found to have good compressive yield strength, but relatively low machinability due to high hardness.

Good potential

"What the research shows is that we have some promising material alternatives to investigate. We have new options for powder forging connecting rods that exhibit compressive yield strength and machinability properties similar to or better than the competing technologies," states Roland. "The next step is follow-up research to find optimum carbon levels and further testing on fatigue strength. In fact, there is such good potential that we will start customer trials with these three new materials later this year."

In pursuit of greater dimensional accuracy

Good dimensional stability is high on the agenda as PM technology strives for high-performance applications.

SIP 1 JUNE 29

The increasing importance of dimensional stability in PM component applications is highlighted in a special interest program at PowderMet 2009.

A growing number of applications, such as variable valve timing components, require extremely tight tolerances. One of the main challenges for PM technology in this area is to produce components that achieve tight tolerances without costly secondary machining.

Creating robust mixes

"Robustness is becoming more and more important for our customers and end users as they try to attain tighter and tighter tolerances on components. The more robust the mix, the greater the chances of achieving tighter tolerances without secondary machining and achieving a more cost-effective solution," says David Milligan Director, Quality, Safety & Environment at North American Höganäs.

Many factors affect dimensional changes in a PM component: powder composition, density, alloying methods, sintering and heat treatment. These issues are covered in a special interest program: A Tour of Dimensional Change: From Why it Happens to How to Control it.

David Milligan and Roland T. Warzel III of North American Höganäs will be chairing the program, which includes four papers from North American Höganäs /Höganäs AB.

"The program reviews the basic factors affecting dimensional change and moves on to discuss case studies on dimensional stability including a cooperative paper with the US PM component manufacturer, Engineered Sintered Components," states David.

Reduce machining

An introduction to the topic is given in the two papers: **Basics of Dimensional Change: Practical Survey of Dimensional Change from Compaction to Ferrous PM Finished Components** by David Milligan, Roland T. Warzel III, North American Höganäs and Ulf Engström, Höganäs AB, and **Effect of Alloying Elements on the Dimensional Change of Ferrous Components** by Roland T. Warzel III & David Milligan, North American Höganäs.

"In these papers we outline what robustness is and what level of robustness can be delivered by each type of mix. What we want to point out is that there are opportunities for improvement, that machining can be reduced, and that more cost-effective production is achievable," emphasizes David.

The second paper analyzes the mechanisms of dimensional change of common alloying elements such as carbon, copper, nickel and phosphorus, and the dimensional stability that can be expected from various alloying systems.

Good dimensional stability will be a critical factor as metal powder technology strives to compete for new high-performance applications. This theme is explored in the paper **High-performance PM Solutions for New Applications** by Ulf Engström and Ola Litström, Höganäs AB, which describes various routes for PM to deliver enhanced mechanical properties and close dimensional tolerances in a cost-effective way.

Improve material handling

The consistency of the alloying elements affects the dimensional change of PM components. Segregation of alloying elements in the blending and handling process can affect the consistency of the final components. There are techniques available to improve material handling and bonding techniques, and consequently reduce the potential segregation of alloying elements. These methods are outlined in the paper: **The Effect of Material Handling, Alloy Addition and Bonding Technique on the Dimensional Stability of Ferrous PM Components** by David Milligan, Denis O'Keefe, Paul Hofecker and Roland T. Warzel III, North American Höganäs.

"Robustness is becoming more and more important for our customers."

In conclusion, David says; "Our aim for the Tour of Dimensional Change special interest program is that people will learn more about what's out there and what they can gain by using the available tools to improve dimensional stability of powder components. This is valuable information – an insight into the cost savings that can be made by eliminating a machining operation is perhaps of even greater interest to customers in the current economic climate."

Catch up with SMC advances

JULY 01

Considerable progress is being made in the Soft Magnetic Composite (SMC) segment and PowderMet 2009 provides an opportunity to find out about the latest developments.

"SMC materials are getting better all the time, electromagnetic designs are improving and more applications are being commercialized," says Ola Andersson, Manager SMC Market Support at Höganäs AB.

Höganäs AB offers SMC solutions via Somaloy® Technology, a complete system of products that ensures the optimal material for different electromagnetic applications. "More and more people are realizing that the 3D magnetic properties and net shaping capabilities of Somaloy materials open up new opportunities to design compact, lightweight and cost-efficient solutions," comments Ola.

The market for SMC solutions has developed to the point that Höganäs AB has now divided up the field into three distinct areas: Fast Switching Actuators & Pulse Transformers, Power Electronics and Electrical Motors. "We know more about the properties of the different Somaloy grades and which are best suited for certain applications. Categorizing them in this way makes it easier to identify the right material in collaborations with customers," states Ola, who outlines the three areas below:

Fast Switching Actuators & Pulse Transformers

"The combination of high magnetic saturation, fast response and 3D-shaping possibilities makes Somaloy a natural choice for this type of application. Somaloy 700 and 1000 materials have been specifically designed to meet the exacting demands on fuel injectors and ignition cores."

Power Electronics

"The Somaloy i-series delivers reduced losses and improved saturation induction and offers ideal solutions for iron powder cores aimed at inductive components. Products in the Somaloy i-series provide a competitive alternative in applications that previously were restricted to laminated electro steel components."

Electrical Motors

"Somaloy makes it possible to design innovative, compact and powerful electric motors to suit a specific application. Somaloy 3P system, for instance, is intended for applications where high permeability and high strength are required.

Another recent development is the launch of a new Somaloy prototyping material.

"Tooling is the preferred approach for manufacturing prototype Somaloy components, but machining the component from a pre-fabricated blank can be a cost-effective alternative. However, in most cases the properties will be different from those obtained by compaction," explains Ola. "The new Somaloy Prototyping Material has enhanced machinability and has been developed in order to minimize these differences. This makes it a lot easier to test new concepts, and the prototyping material is already being used in application projects."

The progress of SMC is charted in the paper: **Advances in Soft Magnetic Composites-Materials and Applications** by Ola Andersson, Höganäs AB, and Paul Hofecker, North American Höganäs.

"This general presentation aims to give people an SMC update and show the benefits and features that are now available," says Ola. "We are constantly working on new materials for the future and will look at one of these. It represents a step forward in SMC materials for electrical motors, because losses are dramatically reduced. The material is set for a limited market release in connection with our collaborative application development projects."

"The potential of SMC is huge," concludes Ola,"but for optimum solutions there needs to be collaboration between the component producer, electrical design engineer and material supplier. Höganäs AB can talk to everyone involved and bring it all together. We are in a unique position as a partner to support the smooth collaboration that is essential for successful application development."

Chromium spearheads advances in lean materials

Lean materials can lead the way to converting more components to PM.

The progress of chromium materials is a powerful theme at PowderMet 2009.

Chromium-alloyed powders are now well-established materials in PM component manufacturing. Höganäs AB introduced Astaloy™ CrM, its first metal powder pre-alloyed with chromium, over 10 years ago and it is now used in high-performance applications such as synchronizing hubs in the automotive industry.

"We want to focus on the good results that can be achieved with these materials using various treatments," says Ulf Engström, Manager PM Components at Höganäs AB.

Interest in chromium materials has risen in recent years due to the price volatility of traditional alloying elements such as nickel and molybdenum.

"Chromium materials offer an attractive alternative," says Sven Bengtsson, Manager Material Development at Höganäs AB, "but often the customer's process has to be adapted to achieve optimum results. Our research helps customers achieve high performance with more cost-effective materials."

The growing appeal of lean materials is reflected in the many chromium-related presentations at PowderMet 2009.

Sven and Ulf will present a paper: **Influence of Processing Conditions on Mechanical Properties** as part of the Special Interest Program, Advances in Lean Materials and Sinter Furnace Alloying.

"We will talk about the necessity to get higher performance from cost-effective chromium materials in order to convert more applications," comments Ulf. "The paper examines the good static and dynamic mechanical properties achievable using new compaction methods, high-temperature sintering and secondary heat treatments."

Increasing options

Höganäs AB is extending alloy alternatives with Astaloy™ CMN, a product designed to deliver excellent properties after heat treatment.

"This new chromium-nickel pre-alloyed base powder is specifically intended for heat treatment. It offers properties comparable to wrought steel and is a more cost-effective alternative to materials with high molybdenum content," states Sven.

The dynamic properties of Astaloy™ CMN are covered in the technical paper: **Fatigue Performance of Cost-effective Cr-Ni Pre-alloyed PM steel, Designed to Replace Fe-Ni steels and Match Wrought Steels** by Alexander Klekovkin, Nagarjuna Nandivana, Ian Howe, North American Höganäs and Sven Bengtsson, Höganäs AB.

Lubrication solution

Chromium-alloyed powders are traditionally considered more difficult to compact than pure iron-powder based mixes and therefore benefit from a more efficient lubricant. A new lubrication system, Intralube® E mix, launched by Höganäs AB in early 2009, offers a lubricant solution for chromium materials.

"Intralube® E is a general product with efficient lubrication for demanding applications, but the interesting aspect is that it performs just as well with chromium materials," points out Mats Larsson, Manager Powder Concepts at Höganäs AB.

> "Chromium materials offer an attractive alternative."

"Using the new zinc-free lubrication system with a heated tool die is an attractive method for achieving sufficient lubrication with a lower amount of lubricant, which is important for achieving high density," states Mats.

Intralube® E is examined in the technical paper: **Performance of Mixes with New Lubricant System Based on Chromium-alloyed Powders** by Mats Larsson, Åsa Ahlin, Höganäs AB and Shawn Miller, North American Höganäs.

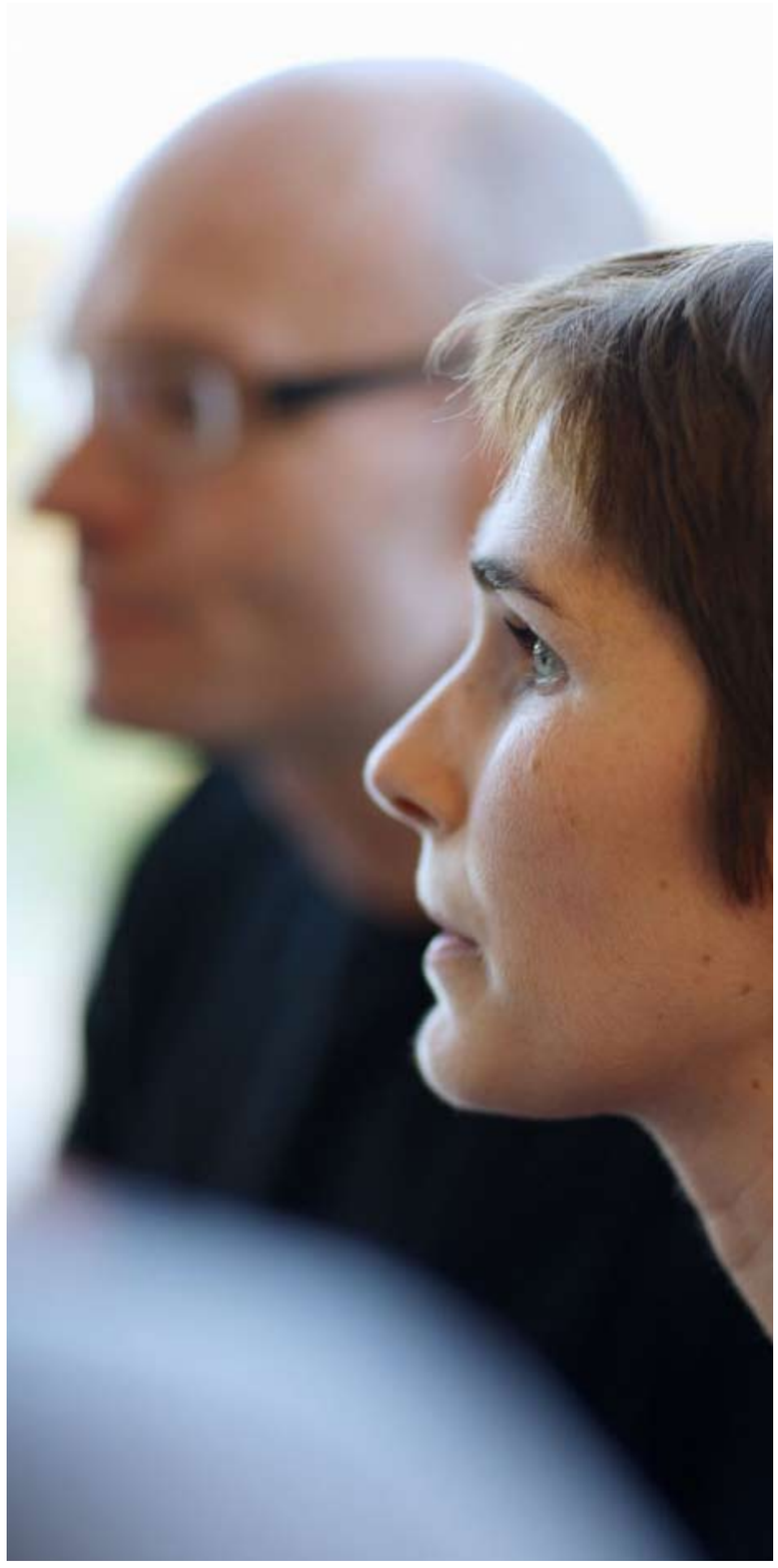
Other Cr-related presentations in brief

- **An Overview of Heat Treatment of Cr-alloyed PM Materials** by Ian Howe, Alex Klekovkin, Shawn Miller, North American Höganäs and Sven Bengtsson, Höganäs AB.

"We will show how chromium materials, including Astaloy™ CMN, can be heat treated. This provides an insight on alternatives and how to achieve best possible results," comments Sven Bengtsson.

- **Surface Engineering of Cr-alloyed PM Steels by Nitriding Treatments** by Ulf Engström, Senad Dizdar, Höganäs AB.

This presents the latest research on combining nitriding and surface densification to improve surface hardness and wear qualities of chromium materials. The two papers mentioned above are part of the SIP4, **Enhanced Mechanical Properties by Post Sinter Processing.**



Improving insight on machinability

The Höganäs Group continues to invest in research and equipment to expand its knowledge on how to improve the machinability of PM components.

JUNE 30

"Research has established that around 60% of sintered PM components require some type of machining. We know that many customers experience that machining is a technically difficult and costly process step and that is why we try to provide good support for improving machinability," says Olof Andersson, R&D Engineer, Powder Concepts at Höganäs AB.

Machining plays a vital role in PM's capacity to produce components of great complexity and often contributes to fulfilling demands for higher surface quality and improved tolerances.

"Even though PM can produce parts near to net shape and with tight tolerances, some components need additional features such as holes, bevels, slots and threads to reach the final shape and geometry," states Olof.

Understanding the characteristics of machinability can be a complex subject, he says: "Machinability of PM steel is not only influenced by the material properties, but also by all the parameters involved in the machining operation such as tool grade and geometry, cutting speed and machine stability."

"However, we are getting better all the time at finding ways to enhance machinability. Our paper at PowderMet 2009 will show how machinability for some sintered PM steels can be improved by optimizing different parameters such as tool material, additives and cutting fluid."

Means to Improve Machinability of Sintered PM Steels by Olof Andersson, Mats Larsson, Höganäs AB and Bo Hu, NAH, outlines the results of comparative tests involving a range of materials from as-sintered, such as iron-copper-carbon and Distaloy® AE, to sinter hardened such as Astaloy™ CrM and Astaloy™ A, when machined under different conditions, with or without cutting fluid and with or without machinability enhancing additives, such as manganese sulfide (MnS) and new additives.

Machinability testing in Höganäs

The Höganäs Group has invested in machinability research with the installation of an advanced lathe at the new Power of Powder Centre in Höganäs, Sweden, which will open officially in October.

"The new lathe means we can perform turning and drilling operations for in-house machinability testing," comments Olof. "The knowledge we gain will be of direct benefit to customers. We can provide customers with recommendations for machining additives, tool materials and machining parameters and then tailor machinability tests to confirm performance of the machining operations. The lathe will also be an important tool for developing new additives."

The Höganäs Group is continuing to look for better ways to enhance machining, not least the pursuit of new machinability-enhancing additives.

Bo Hu, Manager Research Specialty Applications at North American Höganäs is closely involved in the Group's additive development research, "Manganese sulfide is proven as a very effective machinability-enhancing additive for PM components. However, in many cases the machinability-enhancing effect obtained with MnS is not enough when alloying content increases," explains Bo.

"We now have a new machining additive under development that offers considerable machinability improvements. Our other criteria for a new additive are that it is safe and environmentally-friendly, maintains sintered and mechanical properties and is easy to add without special treatment. Customer trials with this new machining additive are now underway and preliminary feedback from key customers is very promising. We are confident the new solutions will add value for our customers."

Opening up new applications for PM stainless steels

Prasan Samal

Advances in sintering offer a brighter future for PM stainless steel parts.

JUNE 29

High-performance routes and low-cost options can offer ways to expand applications for PM stainless steels.

"We need to find more stainless steel applications that can benefit from the advantages that PM offers," says **Prasan Samal**, Manager High Alloys Technical Service at the North American Höganäs Tech Centre. "PM has been regarded as a low-cost alternative meant for less demanding applications, but I think PM also has to go for higher density and high performance."

Prasan sees high-temperature sintering and liquid phase sintering as two good options for achieving higher densities leading to enhanced mechanical properties and corrosion resistance. "In the US a lot of sintering is done in a mesh belt furnace at around 1150º C. With high temperature sintering under well-controlled conditions, one can achieve the density and properties needed to compete for high-performance applications."

"Liquid phase sintering has many advantages, the primary one being the ability to achieve near full-density by the 'single-press, single-sinter process'. The small amount of liquid phase that forms at the sintering temperature promotes rapid diffusion and shrinkage," continues Prasan. "Good control of sintering parameters is essential, but, as with high temperature sintering, we can help the customers. We can assist on the practical side of setting up the process and establishing optimum processing parameters."

New advances in sintering methods and control are making it worthwhile to reassess the potential of existing, but less popular, PM stainless steels. One such reappraisal is the subject of the PowderMet 2009 paper: **Processing and Properties of PM 440C Stainless Steel** by Prasan K Samal, Shawn Miller and Joshua Valko, North American Höganäs.

"As a wrought or MIM stainless steel, this alloy is a well-established solution for applications requiring wear and corrosion resistance" explains Prasan. "We wanted to take a new look at the PM route and see what could be achieved. Using liquid phase sintering and close control, we have obtained a density of 99%, and an as-sintered hardness of HRC 40, which is comparable to that of annealed MIM and wrought 440C products. These findings mean that the potential is there for PM 440C Stainless Steel to compete with the wrought and MIM versions."

A second paper on PM stainless steel looks at making the PM process cost-effective against wrought (casting stamping and machining) options for an existing high-volume automotive application. "Cost reductions can be realized by switching to mesh belt furnace sintering from high temperature sintering," says Prasan. "The opportunity for such a change is stronger in the European market than the US, as the application is fairly new here. This work was conducted in collaboration with a European PM parts producer utilizing a production scale mesh belt furnace." The paper: **A Low-cost Option for Manufacturing PM Stainless Steel Exhaust Flanges and Hego Bosses** by Sten P Millot, FJ Sintermetal; Prasan K Samal, North American Höganäs and Owe Mårs, Höganäs AB is based on the higher sinterability of a newly developed alloy compared to the commonly used 409L.

"Currently, the most popular alloy for these two applications in the US is 409L with a minimum specified sintered density of 7.2 g/cc. High temperature sintering is inevitably the process route to meet this density requirement. Höganäs AB has developed a new PM stainless steel, 410 LV (low-carbon-vanadium), which exhibits higher sinterability compared to 409L, and as such, under the mesh belt sintering conditions (at 1100-1170º C) can reach sintered densities of around 7.0 g/cc. As cost savings are made by switching from high-temperature sintering to low-temperature sintering, this low-cost option could be of interest to exhaust flange and HEGO boss makers who are reassessing overdesigned wrought steel components and looking for cost-savings."

Prasan considers the outlook for PM stainless steels is good. "I think there are opportunities, particularly in these times when customers and end users are looking for new ideas and alternatives to cut component costs. If we can deliver the required properties and support the customers on the processing side, then we can gain ground."

Höganäs

PRESENTATIONS

AT PowderMet2009, LAS VEGAS JUNE 28-JULY 1

Monday, June 29

Session 01

• *0118 U.S.A. & Sweden*

Fatigue Performance of Cost-Effective Cr-Ni Prealloyed PM Steel, Designed to Replace Fe-Ni Steels and Match Wrought Steels

Alexander Klekovkin, Nagarjuna Nandivada, Ian Howe, North American Höganäs, Inc. & Sven Bengtsson, Höganäs AB

Session 04

• *0119 U.S.A.*

Processing and Properties of PM 440C Stainless Steel

Prasan K. Samal, Shawn Miller, Joshua Valko, North American Höganäs, Inc.

Session 09

• *0143 Sweden & U.S.A.*

Performance of Mixes with New Lubricant System Based on Chromium-Alloyed Powders

Mats Larsson, Åsa Ahlin, Höganäs AB & Shawn Miller, North American Höganäs, Inc.

Session 10

• *0168 Denmark, U.S.A. & Sweden*

A Low-Cost Option for Manufacturing PM Stainless Steel Exhaust Flanges and HEGO Bosses

Sten P. Millot, FJ Sintermetal, Prasan K. Samal, North American Höganäs, Inc. & Owe Mårs, Höganäs AB

SIP 1

• *0210 U.S.A. & Sweden*

Basics of Dimensional Change: Practical Survey of Dimensional Change from Compaction to Ferrous PM Finished Product

David Milligan, Roland T. Warzel III, North American Höganäs, Inc. & Ulf Engström, Höganäs AB

• *0199 U.S.A.*

Effect of Alloying Elements on the Dimensional Change of Ferrous Components

Roland T. Warzel III, David Milligan, North American Höganäs, Inc.

• 0136 Sweden

High-Performance PM Solutions for New Applications

Ulf Engström, Ola Litström, Höganäs AB

• *0200 U.S.A.*

The Effect of Material Handling, Alloy Addition, and Bonding Technique on the Dimensional Stability of Ferrous PM Components

David Milligan, Denis O'Keefe, Paul Hofecker, Roland T. Warzel III, North American Höganäs, Inc.

Tuesday, June 30

Session 21

• *0057 U.S.A. & Sweden*

New Materials for Powder-Forged Connecting Rods

Roland T. Warzel III, Ian Howe, Nagarjuna Nandivada, North American Höganäs, Inc. & Sven Bengtsson, Anders Bergmark, Höganäs AB

Session 28

• *0086 U.S.A.*

Machinability Improvement of PM Components with Using Machinability-Enhancing Additives

Bo Hu, Roland T. Warzel III, North American Höganäs, Inc. & Suresh Shah, Jerry Falleur, Cloyes Gear and Products, Inc.

Session 28

• *0135 Sweden*

Means to Improve Machinability of Sintered PM Steels

Olof Andersson, Mats Larsson, Höganäs AB

SIP4

• *0203 Sweden*

Surface Engineering of Cr-alloyed PM Steels by Nitriding Treatments

Ulf Engström, Senad Dizdar, Höganäs AB

• *0198 U.S.A. & Sweden*

An Overview of Heat Treatment of Cr Alloyed PM Materials

Ian Howe, Alex Klekovkin, Shawn Miller, North American Höganäs, Inc. & Sven Bengtsson, Höganäs AB

Wednesday, July 1

Session 42

• *0044 Sweden & U.S.A.*

Advances in Soft Magnetic Composites — Materials and Applications

Ola Andersson, Höganäs AB & Paul Hofecker, North American Höganäs, Inc.

SIP5

• *0137 Sweden*

Influence of Processing Conditions on Mechanical Properties

Sven Bengtsson, Ulf Engström, Höganäs AB

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