

# POWDER

**SPECIAL ISSUE**  
 PM<sup>2</sup>TEC2003  
 JUNE 8-12, LAS VEGAS



**NORTH AMERICAN HÖGANÄS AND SCM**

**side by side**

**A T P M <sup>2</sup> T E C 2 0 0 3**

*Höganäs AB's aim to become a full-range metal powder producer for the North American market has taken a major leap forward with the acquisition of SCM Metal Products, Inc., USA.*

North American Höganäs and SCM, a manufacturer of specialty iron and metal powders with a range of over 1,000 products, will be exhibiting together for the first time at PM<sup>2</sup>TEC2003, held in Las Vegas, June 8-12.

"SCM will be appearing side by side with us at our stand. We are two successful companies with good synergies and together we can add value for customers," says President of North American Höganäs, Sten-Åke Kvist.

Ron Solomon, Business Manager of SCM, adds: "Our message at the show will be that we are now North American Höganäs - we will combine SCM's strengths with Höganäs Group's strengths to make a better

company to meet the industry's needs today and tomorrow."

**Leading-edge research**

For many years Höganäs AB has played a leading role in taking R&D forward in the P/M field. The Group's R&D team will present no less than 9 technical papers and 4 special interest programs at PM<sup>2</sup>TEC2003.

Ulf Engström, Technology Director of the Tech Center at Stony Creek, says: "The theme running through the papers is our pursuit of high performance, improved tolerances and lower total costs. Our SMC papers also show how we are breaking into new areas."

Papers examining various aspects of chromium materials, bonded mixes and gear production reflect the current focus on gears in the US market. "Many gears are already made using P/M technology, but transmission gears offer huge potential for expansion. Our research on both materials and manufacturing processes is helping to bring that market within reach," concludes Ulf.

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# SCM acquisition: A GOLDEN O

*The Höganäs Group's position in North America has been considerably strengthened and broadened by the strategic acquisition of the major US copper and high alloy powder producer, SCM.*

Höganäs AB completed the acquisition of SCM Metal Products, Inc., USA, a manufacturer of specialty metal powders in April. SCM was acquired from the OM Group, Inc., for a price of USD 65 M.

Since the 1970s, Höganäs AB has successfully expanded beyond its traditional focus on iron powder to high alloy materials, most noticeably with the acquisition in the mid-1980s of Coldstream, a European company specializing in high alloy powder products. The US market for high alloy powders accounts for around 50 percent of the world market.

Sten-Åke Kvist, President of North American Höganäs, says: "Our presence in the high alloy segment of the US market has up to now been very small and as part of our strategy we wanted to expand in this area. When we found that SCM was for sale, we knew it was a golden opportunity to gain a strong position in this market."

#### Improved product mix

SCM has been in continuous operation for 70 years and offers more than 1,000 powdered metal products – many of them new to the Höganäs Group – from its production

facilities at Research Triangle Park, North Carolina and Johnstown, Pennsylvania. The two plants, both certified to ISO 9002 and QS 9000 standards, run a wide variety of screening, milling, grinding, blending, and mixing processes.

SCM operates North America's largest induction melting unit for the production of stainless steel powders and manufactures more than a dozen fully alloyed grades by water atomization. The company is the sole North American manufacturer of electrolytically refined iron powder. Other products include nickel alloy powders, copper powders, copper oxides, and special copper-aluminum alloys. Among SCM's niche products are GlidCop®, a high strength copper alloy of high conductivity, and Cubond®, a brazing paste widely used in the automotive industry.

As SCM employs about 200 people, the acquisition more than doubles the Höganäs Group's work force in the USA from 160 to around 360.

SCM will be run as an independent unit of the Höganäs Group's operations in North America. North American Höganäs now operates from five US sites (see box).

#### Extensive synergies

Höganäs AB and SCM are a good match in several key areas – including product mix, manufacturing techniques and R&D focus.

"SCM is a company with many outstanding products," says Sten-Åke Kvist. "It has a strong position in stainless steel powders and they are also very strong in copper powders, which is a new area for Höganäs AB. They can take us into many new copper-based niches, where they have carved out strong positions."

"The biggest synergy is that we have very complimentary products," adds Ron Solomon, Business Manager of SCM. "Many of our products, such as copper powder, are very usable in the Höganäs Group's organization."

"Our main market is the North American automotive stainless steel market which is also an area that complements Höganäs AB's efforts," he continues. "Our stainless steel powders are used in applications such as exhaust flanges and ABS sensor rings."

In technical and manufacturing matters, there is a striking similarity of approach. Sten-Åke Kvist comments: "Technically, both companies have a record of constantly creating new products by always looking for better solutions. We both strive to improve quality and reduce costs. One interesting aspect is the use of different technologies. SCM uses different processes for similar

# OPPORTUNITY

## seized in the US market

products to ours in Europe. This opens up the way for cross fertilization in both directions between Europe and the US."

"We are both companies that have historically stressed technical excellence – we foresee joint efforts using the best of our technologies to help our customers and the industry grow and expand into new PM applications," states Ron Solomon.

The acquisition of SCM brings together two companies with an intensive focus on R&D. In the US, North American Höganäs already has the Tech Center at Stony Creek, which provides technical support and application development on the iron powder side. SCM's R&D center at the North Carolina facility was established in 1990 and is dedicated to development that will expand the SCM product line. This facility will now also cooperate closely with Coldstream Division researchers in Europe on high alloy powder development.

Sten-Åke Kvist says: "SCM has a very well equipped R&D facility with highly knowledgeable staff. This is a very nice fit with Höganäs AB, which is a very R&D focused company. There are many technical and R&D synergies to be exploited. By adding together our collective strengths and expertise, we can add more value for our customers in many of our established metal powder areas, as well as many new ones."



**George Gillespie,**  
President of  
SCM Metal Products, Inc.

**Ron Solomon,**  
Business Manager of  
SCM Metal Products, Inc.

**Sten-Åke Kvist,**  
President of North  
American Höganäs, Inc.

**Ulf Engström,**  
Technology Director  
of the Tech Center  
at Stony Creek.

### Five star service from five US sites

SCM is the latest addition to North American Höganäs, which has expanded rapidly since it was formed in 1999. Pyron, a leading producer of powders for friction applications was acquired in 2000. North American Höganäs now serves its customers in the USA, Mexico and Canada from five US sites.

#### Stony Creek, Pennsylvania

Officially opened in October 2001, this state-of-the-art fully integrated facility is one of the world's largest atomized iron and steel powder plants with an annual capacity of 300,000 tons.

#### Niagara Falls, New York

A production facility for the highly specialized iron powders used in friction applications.

#### St Marys, Pennsylvania

This local mixing station serves the needs of a cluster of P/M component makers with rapid delivery of small lots of metal powders.

**Research Triangle Park, North Carolina (SCM)**  
Production plant for copper powders, copper oxides, non-ferrous powders and Cubond® brazing pastes.

#### Johnstown, Pennsylvania (SCM)

Production facility for alloy powders such as stainless steel, Glidcop® and melt stock/iron powder.

### Good news for Höganäs AB and SCM

"SCM's strong position in the North American market will be of great strategic value to the Höganäs Group's Coldstream Division, which is now well-placed in the European and Asian markets. And with Höganäs AB's global sales network, SCM's products should be able to achieve good penetration outside North America."

*Claes Lindqvist, President and CEO of Höganäs AB*

"This acquisition shows that we are very committed to the North American market and want to be a full range producer. Step by step we are building up our capability. SCM makes us an even stronger player in the US metal powder market, and we are now strong in many more niches."

*Sten-Åke Kvist, President of North American Höganäs, Inc.*

"For SCM, we look forward to having the resources of the Höganäs Group behind us to expand and further improve our products for the world marketplace. We feel that as a team, we will be able to better serve the US market with existing products as well as new innovations to drive the growth of the overall P/M industry."

*George Gillespie, President of SCM Metal Products, Inc.*



# HIGH PERFORMANCE AT LOW COST

*Do chromium materials offer the best route to the next level of high performance P/M components such as transmission gears? Two new papers show that Astaloy CrM is leading the way.*

Astaloy CrM is a metal powder prealloyed with chromium that can be tailored for high performance components. The powder is already being used in commercial applications for powder components that require high strength and wear resistance, such as gears. The latest research on this unique chromium material suggests it is also a competitive material for more highly loaded components like transmission gears.

Barbara Maroli, who along with Ulf Engström, Peter Thorne and Sigurd Berg has written the paper **Sinter Hardening and Heat treatment of Materials Based on Astaloy CrM** says: "Elongation is something that P/M steels need to improve on. We have been looking at ways to enhance both elongation and strength by modifying processing conditions to change the microstructure."

The study spotlights the property variations when sintering Astaloy CrM at different temperatures. High temperature sintering at 1250° C (2280° F) produced a tensile strength of 1500 MPa (218 ksi) combined with an elongation of 2.5%.

"These impressive figures show that we have a good material and a good single compaction and sintering process that together offer the very high strength and good elongation that is needed for highly loaded components," says Sigurd Berg. "Using this material and high temperature sintering means the potential exists to get required properties in a simple way – heat treatment is eliminated and that means reduced costs."

As it is prealloyed, Astaloy CrM has good dimensional control. The presentation of the paper at PM<sup>2</sup>TEC2003 will also feature a case study demonstrating the

highly satisfactory dimensional scatter results for an Astaloy CrM-based gear sintered at 1120° C (2050° F).

## Excellent fatigue properties

Good fatigue properties are a vital issue if P/M steels are to be applied more in the production of highly loaded components. Microstructure and density are the main factors affecting fatigue properties. What impact do different alloying systems, such as Astaloy CrM, and processing conditions have on microstructure and fatigue properties? This was the question tackled by Ola Bergman and Anders Bergmark in the paper – **Influence of Microstructure on the Fatigue Performance of PM Steels**.

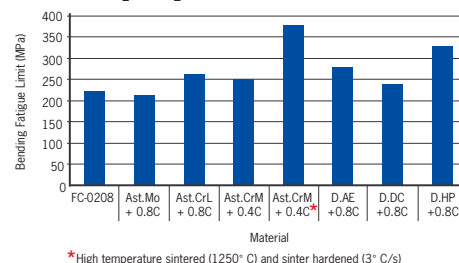
"When Astaloy CrM was high temperature sintered at 1250° C (2280° F) an excellent fatigue strength of 380 MPa (55 ksi) was attained," says Ola Bergman. "This shows that a chrome material can deliver very good fatigue properties from a simple single compaction and sintering process."

## Chromium potential

Ulf Engström will be giving an overview of various processing methods and alloys, including Astaloy CrM, in a special interest program at PM<sup>2</sup>TEC2003: **High Performance P/M Steels Obtained by Different Heat Treatment Operations**.

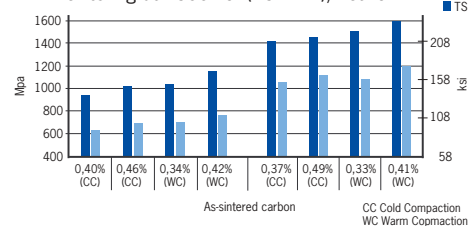
Ulf sums up the appeal of chromium for the P/M industry: "It is a low-cost alloy that performs well. I believe chromium materials have the capability to deliver the properties needed for transmission gears and our papers will show that we are well on the way to realizing that potential."

Fatigue limits in plane bending (2 million cycles, R = -1) for PM steels with density 7.1 g/cm<sup>3</sup> sintered at 1120° C for 30 minutes in 90N<sub>2</sub>/10H<sub>2</sub>

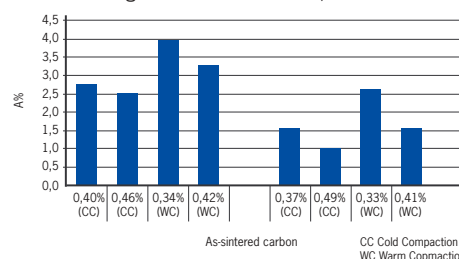


\*High temperature sintered (1250° C) and sinter hardened (3° C/s)

Tensile and yield strength obtained after sintering at 1300° C (2372° F), Ast. CrM



Elongation obtained after sintering at 1300° C (2372° F), Ast. CrM



## Focus on chromium

Höganäs AB has long been a leader in metal powder product development. Chromium, a high strength, environmentally friendly, low-cost alloying element has been the subject of intensive R&D by the company since 1993. In the past 10 years the Höganäs Group has built up unrivaled knowledge on chromium as a P/M alloying element and introduced the first metal powders prealloyed with chromium for mass production applications – Astaloy CrM (1998) and Astaloy CrL (2002).

# The case for P/M gears takes shape

**Results from new prototype gear tests show that the dimensional accuracy of P/M gears can match that of conventional wrought steel gears and effectively eliminate costly machining operations.**

A new paper, **Process, Quality and Properties of High-Density P/M Gears**: by Senad Dizdar, Sven Bengtsson and Paul Skoglund, – shows that materials and processing methods are now capable of delivering high density P/M gears with a dimensional accuracy equivalent to conventional hobbled gears.

The paper examines aspects of high performance P/M prototype gears made by a high-density manufacturing route and sinter hardening. These prototype P/M gears, produced by compacting Astaloy CrM to a density of 7.5g/cm<sup>3</sup>, were compared to reference gears made of heat treated wrought steel.

“Our paper shows that there is a clear shaping advantage with P/M gears. They are in the same AGMA quality class as hobbled gears. In practical terms this means that costly machining operations such as turning and hobbing can be avoided and material utilization is better compared to conventional gears,” say Paul Skoglund.



P/M prototype gear

The performance of the high density gears made by a cost-efficient press and sinter hardening route was found to be very near the performance of wrought steel gears used in medium duty gear applications.

Sven Bengtsson emphasises: “It is not only achieving the right properties for gears, but doing it at a competitive cost. I think our findings indicate that P/M technology is already an excellent alternative for medium-range gear applications because the process used was the simplest possible – just press and sinter.”

Billions of transmission gears are produced each year, offering a huge potential market. Although P/M gears are gaining ground in many gear segments, automotive transmission gears have offered a tough challenge to P/M technology. P/M gears must match the gear strength of conventional wrought steel gears, but also fulfil other exacting requirements in areas such as surface finish and dimensional accuracy.

Paul says that Höganäs AB’s R&D efforts are gradually addressing these areas to provide hard evidence that P/M gears can be used successfully in higher performance applications: “We are getting closer and closer. We have already looked at static properties. Now with this paper we have shown that dimensional accuracy of a comparable quality to wrought steel gears can be achieved, which opens possibilities to lower manufacturing costs. In the future we will be looking at how case-hardened high-density P/M steels can measure up to conventional steel in terms of gear strength for these applications. We will also focus on another important aspect of P/M gears that is vital for automotive transmission requirements: pitting resistance.”

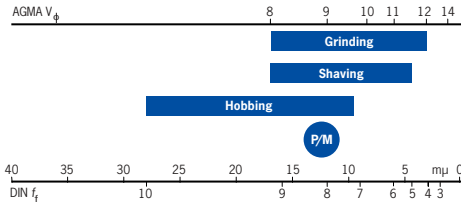
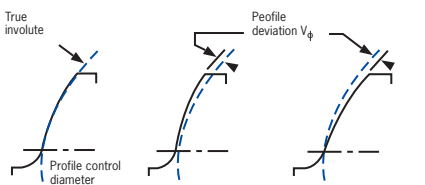
## Simpler processing

Another paper will deal with gears and simplified processing alternatives: **Comparison of Fatigue Properties of Heat Treated Gears Obtained by Double Pressing and Sintering and Warm Compaction** by North American Höganäs, Inc., Höganäs AB and Brockway Pressed Metals.

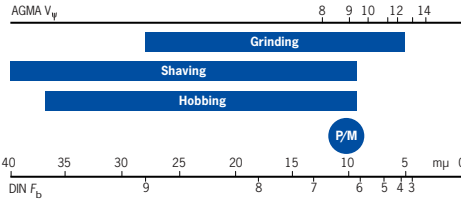
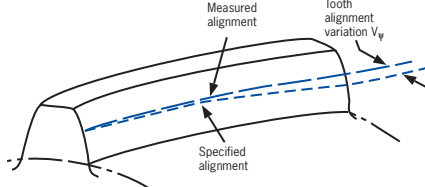
“This paper is typical of our R&D work,” says Ulf Engström, “because it shows the knowledge we have that can help the industry to achieve the same or better properties for gear applications for a lower total cost. In this case we demonstrate how process stages can be eliminated by using warm compaction.”

## GEAR QUALITY

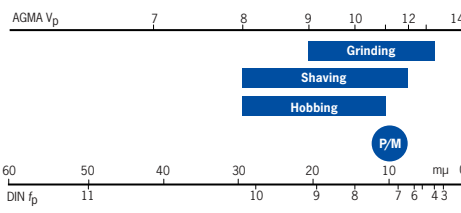
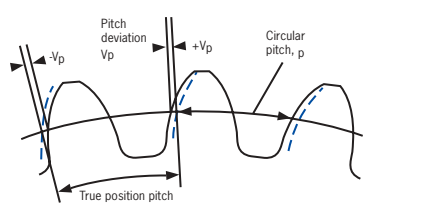
### Profile deviation



### Alignment deviation



### Pitch deviation



## Focus on gears

Höganäs AB is committed to widening applications for P/M gears. Transmission gears for automotive applications is a prioritised R&D area. Extensive resources are being directed to examine both the materials and manufacturing routes that have the potential to reach the required properties. Special emphasis is also being given to finding ways to reduce the number of stages in gear production in order to increase the competitiveness of powder components.

# The right mix to BOOST PRODUCTIVITY

*Solid evidence that bonded mixes offer substantial productivity gains in gear and component manufacturing compared to pre-mixes is supplied in a new paper for PM<sup>2</sup>TEC2003.*

Premix or bonded mix? The latest paper from North American Höganäs and Höganäs AB on bonded mixes – **Close dimensional stability at high production rates:** Hilmar Vidarsson, Sigurd Berg, Daniel Edman, Björn Johansson, Peter Thorne – adds to the growing body of research results that show Starmix can considerably increase component compaction rates.

Hilmar Vidarsson explains the limitations of pre-mixes: “What we have seen in production using conventional mixes is that if you try to increase productivity, you get instabilities. This puts a very definite limit to how many parts you can produce per minute. Starmix is a bonded mix that offers a way of getting a step ahead and pushing up productivity. In fact, we have often found that the limiting factor on production rate in tests is the top speed of the press.”

“Starmix has a range of benefits that contribute to increased productivity with stable dimensional scatter,” states Daniel Edman. “The key is improved flowability, which facilitates fast and efficient filling of the tool die, and this means compaction speeds can be increased at the press. And the bonding structure means that segregation of alloying elements is minimized.”



*Courtesy of  
Pennsylvania  
Powdered  
Metals*

## Production gains

Laboratory tests cited in the paper indicate likely productivity rises of up to 40% by switching to Starmix. Production tests on 28-tooth gears carried out on a mechanical press at a component manufacturer in Pennsylvania compared results from unbonded mix and Starmix.

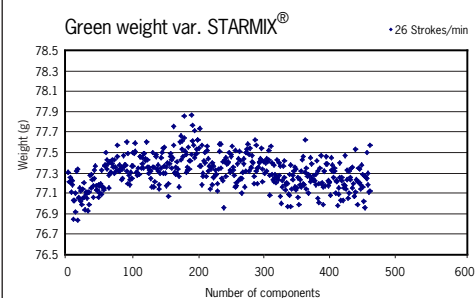
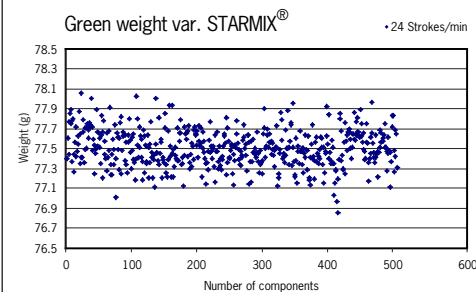
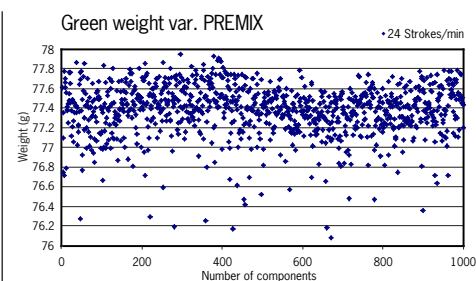
“The results were highly satisfactory. Starmix produced 26 gears per minute compared to 20 using the premix. That’s a rise of 30%,” says Daniel. “At 24 components per minute, the dimensional scatter of the premix increased dramatically. Starmix achieved the increased speed with maintained tolerances and no change in dimensional scatter.”

Sigurd Berg adds, “Starmix has enabled actual productivity increases of 21% in commercial production at one of our customers.”

“Our conclusion” says Hilmar, “is that it is possible to increase production to high rates with better or maintained tolerances by choosing a bonded mix. Starmix is therefore an interesting option for manufacturers who are looking for an alternative that can provide good distribution of alloy, better fillability and increased productivity.”

As well as economic advantages, bonded mixes also offer benefits for the working environment. Because it is bonded, the mix creates less dusting of fine particles during handling and pressing of components. The paper also presents further evidence that bonded mixes contribute to a cleaner workplace.

Another paper concerning bonded mixes presented at PM<sup>2</sup>TEC2003 is: **Efficient Low-Alloy PM Steels for High Performance Structural Applications** by North American Höganäs, Inc., Höganäs AB and HAWK.



## Focus on bonded mixes

Höganäs AB launched its organically bonded mix, Starmix, in the mid-1980s.

Bonded mixes are increasingly replacing unbonded mixes in gear production and other applications as they offer opportunities to improve efficiency and streamline production. Over the years, the Höganäs Group’s R&D has highlighted several advantages of bonded mixes: improved flowability and fillability, better weight stability and dimensional stability, and reduced dusting and dust loss.

# Leading the SMC revolution



*Two presentations from Höganäs AB on Soft Magnetic Composites (SMCs) reflect the Group's continuing dominance in this innovative new technology.*

The SMC revolution is gathering momentum. SMC technology is expanding beyond established areas of application such as iron cores in electronic circuits and ignition coils for cars into a huge new potential area – electric motors.

SMC materials offer unique 3-D design possibilities opening the way for innovations in electric motors and machinery. More and more SMC components are being produced commercially, and in 2002 companies such as Japanese Aisin Seiki began manufacturing electric servo-motors for ABS brake systems.

## The right atmosphere

As SMC technology moves increasingly into commercial applications, Höganäs AB's SMC research has intensified its focus on the process side. **SMC Part Manufacturing and Quality Assurance:** by Zhou Ye and Lars-Olov Pennander, looks at the optimization of heat treatment for SMC parts.

The manufacturing route for SMC parts is largely the same as for P/M components, with the exception of heat treatment. Magnetic and mechanical properties of SMC parts are optimized by heat treatment at low temperature.

Lars-Olov Pennander says: "Manufacturers are used to sintering. Somaloy with

Kenolube lubricant is heated at just 500° C (932° F). It's important that manufacturers understand that the SMC heat treatment process is very different."

Based on laboratory tests and full-scale production tests, the paper identifies optimized processing parameters for heat treatment, considering factors such as component size and density, amount of lubricant and furnace atmosphere.

Previous research has shown that temperature is very important for treatment outcomes, but the new study also proves the crucial role of atmosphere.

"Carbon monoxide, which is harmful to SMC parts, can be formed in the furnace," explains Lars-Olov. "We found good ventilation or extra air flow could solve the problem."

"These and the other findings in our paper will act as a further refinement to initial process recommendations and help manufacturers to produce quality SMC parts."

## A unique coating

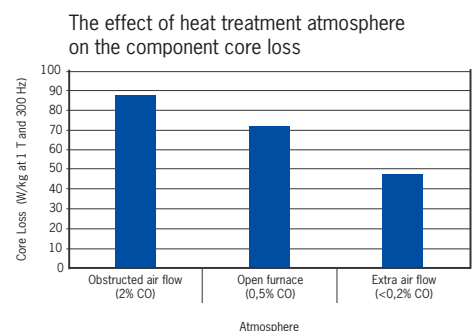
SMC is a new technology and misconceptions still exist about SMC materials and their potential. What makes SMC materials unique? The answer is in the coating, explains Ola Andersson in his presentation, **The Effect of Coating on Soft Magnetic Materials.**

SMC materials are basically iron powder particles coated with an insulating layer to avoid electrical contact between the particles. However, there are other ways to produce soft magnetic components. Alloyed sintered components can be used for DC or very low

frequency applications. Another alternative is to blend polymers with iron powder particles to increase resistivity.

"These alternatives to SMC have been around for a long time," says Ola, "but because either their electrical resistivity or permeability is too low, the use of these alternatives is limited in electrical machines."

"The coating of SMC material offers greater benefits because it creates a unique combination of high resistivity and high permeability. And not only that, these properties are all usable in a 3-D design, so the coating opens up a wider range of applications."



## Focus on SMC technology

Höganäs AB launched the first SMC materials in 1993 and has been the leading R&D force in this specialized field ever since. The Group is driving SMC technology forward through technical development of materials and processes for new components. Cooperation with end users is considered an essential element in establishing SMC technology. The Höganäs Group is currently involved in more than 40 projects with manufacturers of electrical machines, primarily motor producers.

# TECHNICAL PRESENTATIONS

## AT THE PM<sup>2</sup>TEC2003 CONFERENCE, LAS VEGAS, JUNE 9-12

Monday June 9	Tuesday June 10	Wednesday June 11	Thursday June 12
<p><b>Effect of Time at Temperature and Cooling Rate on Properties of Sinter-Hardenable Materials</b></p> <p>North American Höganäs, Inc.  <i>Ingalill Nyberg</i>  <i>Mary Schmidt</i>  <i>Bo Hu</i>  <i>Peter Thorne</i></p> <p>ABBOTT Furnace Co.  <i>Thomas J. Jesberger</i>  <i>Stephen Feldbauer</i>  <i>Jason Gabler</i></p>	<p><b>Dimensional Control Using Chromium Alloyed Materials Versus Conventional P/M Alloyed Materials</b></p> <p>North American Höganäs, Inc.  <i>Bo Hu</i>  <i>Alex Klekovkin</i></p> <p>Höganäs AB  <i>Sigurd Berg</i></p> <p>HAWK  <i>Rick Young</i></p> <hr/> <p><b>Sinter-Hardening and Heat Treatment of Materials Based on Astaloy CrM</b></p> <p>Höganäs AB  <i>Barbara Maroli</i>  <i>Sigurd Berg</i></p> <p>North American Höganäs, Inc.  <i>Peter Thorne</i>  <i>Ulf Engström</i></p> <hr/> <p><b>Influence of Microstructure on the Fatigue Performance of PM Steels</b></p> <p>Höganäs AB  <i>Ola Bergman</i>  <i>Anders Bergmark</i></p> <hr/> <p><b>Close Dimensional Stability at High Production Rates</b></p> <p>Höganäs AB  <i>Hilmar Vidarsson</i>  <i>Sigurd Berg</i>  <i>Daniel Edman</i>  <i>Björn Johansson</i></p> <p>North American Höganäs, Inc.  <i>Peter Thorne</i></p>	<p><b>Process, Quality and Properties of High-Density P/M Gears</b></p> <p>Höganäs AB  <i>Senad Dizdar</i>  <i>Sven Bengtsson</i>  <i>Paul Skoglund</i></p> <hr/> <p><b>Comparison of Fatigue Properties of Heat Treated Gears Obtained by Double Pressing and Sintering and Warm Compaction</b></p> <p>North American Höganäs, Inc.  <i>David Milligan</i>  <i>Paul Hofecker</i>  <i>Ulf Engström</i></p> <p>Höganäs AB  <i>Senad Dizdar</i></p> <p>Brockway Pressed Metals  <i>Jim Lingenfelter</i></p> <hr/> <p><b>Efficient Low-Alloy PM Steels for High Performance for Structural Applications</b></p> <p>North American Höganäs, Inc.  <i>Alex Klekovkin</i>  <i>Ulf Engström</i></p> <p>Höganäs AB  <i>Sigurd Berg</i></p> <p>HAWK  <i>Bill Edwards</i>  <i>Leonid Frayman</i>  <i>Gerd Hinzman</i>  <i>Dax Whitehouse</i></p> <hr/> <p><b>SPECIAL INTEREST PROGRAM</b></p> <p><b>Sinter Brazing of P/M Components</b></p> <p>Höganäs AB  <i>Owe Märs</i></p>	<p><b>High Density Sintered Stainless Steel</b></p> <p>Höganäs AB  <i>Ricardo Canto Leyton</i></p> <hr/> <p><b>SPECIAL INTEREST PROGRAMS</b></p> <p><b>High Performance P/M Steels Obtained by Different Heat Treat Operations</b></p> <p>North American Höganäs, Inc.  <i>Ulf Engström</i></p> <hr/> <p><b>SMC Part Manufacturing and Quality Assurance</b></p> <p>Höganäs AB  <i>Zhou Ye</i>  <i>Lars-Olov Pennander</i></p> <hr/> <p><b>The Effect of Coating on Soft Magnetic Composite Materials</b></p> <p>Höganäs AB  <i>Ola Andersson</i></p>
<p>For daily update of presentations visit <a href="http://www.hoganas.com">www.hoganas.com</a></p>			