

## Showcasing our Finest at Furnaces North America 2008

Morgan Technical Ceramics Bolt Technical Ceramics (MTC Bolt Technical Ceramics) showcased its ceramic products, including thermal protective sheathing tubes, SILLIMANTIN mullite rollers, fused silica rollers and HALSIC high performance silicon carbide (SiC) materials at Furnaces North America at the Renaissance Nashville Hotel and Convention Center in Nashville, Tennessee, October 21 – 22, 2008. MTC Bolt Technical Ceramics is a distributor for the products manufactured by MTC's Haldenwanger operations in Germany and China.

MTC Bolt Technical Ceramics' thermal protective sheathing tubes, composed of high performance aluminum oxide (alumina) and aluminum silicate (mullite), ensures reliable measurement and process control, protecting sensitive temperature sensors in extremely high temperature and high corrosion environments. The tubes are available in gastight or porous versions, and in both SAE and metric dimensions. For slightly lower working temperatures, MTC Bolt Technical Ceramics additionally offers its PYTHAGORAS material, which provides excellent resistance against

chemical attack and thermal shock.

Also on exhibit was MTC Bolt Technical Ceramic's SILLIMANTIN mullite rollers. SILLIMANTIN-60 and SILLIMANTIN-65 oxide ceramic rollers, composed of mullite materials, are utilized in the firing of wall and floor tiles. The high performance SILLIMANTIN-90 provides a cost-effective solution for firing large format porcelain stoneware tiles, offering outstanding resistance to high temperatures, temperature changes and chemical attack.

Additionally, MTC Bolt Technical Ceramics' displayed its fused silica rollers which offer outstanding mechanical properties and special surface quality. This makes them ideal as transport rollers for tempering flat glass used in a variety of industries, such as the manufacturing of tempered safety glass for the automobile industry, and in architectural applications, such as shop-window glass, curtain walls and glass doors.

Lastly, the company showcased its HALSIC high performance SiC materials for kiln furniture and other high-temperature environments. HALSIC provides absolute dimensional stability and thermal shock resistance despite extreme mechanical strain, with typical thermal management applications including tubes and rollers used in roller kilns, as well as rectangular



batts, setting rings, and plate setters for porcelain production.

With decades of experience, MTC Bolt Technical Ceramics is a leading supplier of customized ceramic components to meet specific application needs.

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**Morgan**  
Morgan Technical Ceramics

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Innovation in Materials Technology

March 2009

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NEWS RELEASE

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Given the economic environment this is clearly an outstanding performance and we should all feel rightly pleased with the results

The Technical Ceramics Division had a strong finish to the year 2008. It was in many ways a watershed year for us. We completed a major acquisition and saw many industrial markets turn down. Despite this decline revenues for the second half of 2008 were £113.9 million (2007: £74.8 million), an overall increase of 52%. This included £27.0 million of revenue contributed by the businesses acquired from Carpenter at the end of March. At constant currency, second half revenue in Technical Ceramics excluding the Carpenter businesses showed 3% organic growth compared to the prior year. These second half results took total sales for the year to £212.2 million (2007: £152.6 million) an overall increase of 39%. Like-for-like organic revenue growth (at constant currency and excluding acquisitions) was 3.3%. Given the economic environment this is clearly an outstanding performance and we should all feel rightly pleased with the results.

In the US, demand was robust for aerospace applications in our metals business, and for our advanced medical components. In combination, these businesses offset some softness in more economically cyclical end-markets such as consumer electronics.

Our European and Asian regions performed well with particularly strong performance from our thermal processing business; in part driven by the demand in the solar energy market. The site in Shanghai was successfully closed during the second half of the year as we continue to move away from commoditised product lines.

The businesses acquired from Carpenter have made an excellent start with both revenues and profits ahead of expectations and a good order book going into 2009. The business is enjoying continued strong demand from the industrial gas turbine market.

Andrew Hosty CEO

During quarter four of 2008 we integrated the management of the businesses into our regional reporting structure.

As a result of caution from our customers, caused by the uncertain outlook, the Division's order books are currently below the same point last year. Whilst this reduces visibility for the business it has not fed through into sales rates. Counteracting this, many of our key markets remain robust. Importantly we still expect to see the hard disk drive business start ramping to volume during the second half of 2009. The Division entered into a strategic partnership in H2, with the industry market leader, to develop and supply components for future generations of hard disc drives.

Divisional EBITA was £17.5 million in H2 (2007: £10.8 million), an increase of 62%. This included £4.2 million of EBITA from the acquired businesses. At constant currency, divisional EBITA growth in the continuing businesses was 6.6% versus the second half of 2007.

Divisional EBITA margins for the year in the continuing business improved to 14.6% (2007: 13.0%), and the acquired businesses enhanced this further by delivered EBITA margins of 15.9%, resulting in an overall divisional EBITA margin for the division of 14.8%

The division continued to make progress with EBITA rising to £31.5 million (2007: £19.9 million ) Consequently we remain cautiously optimistic about the future.

Our focus in 2009 will be to continue to build our business around customers and markets that are themselves growing whilst keeping a keen eye on costs so that we are as well placed as we can be to invest in the many opportunities that are around us.

My thanks to all of our employees for your continued hard work and dedication and to our customers for their continued loyalty and support.

## Celebrating 40 year collaboration with multi million euro contract



Morgan Technical Ceramics (MTC), designer and manufacturer of technical ceramic components, has secured a new multi-million pound contract with leading pump manufacturer, Grundfos. The deal coincided with two other celebrations at MTC's Stourport site: the opening of the new 'Volume Precision Ceramics' department and the two companies' 40 year anniversary of working together, a collaboration that has led to significant developments in new pump technology over the last four decades.

The new contract will cover the production of a variety of precision ground ceramic components, including thrust washers, seal rings, shafts and bearings, the latter being the first ever product supplied by the technical ceramics firm to the pump manufacturer in 1968. Since then the two companies have worked together on several new product developments for both domestic and industrial pumps, including the circulator pumps used within central and distributing heating systems.

"The reliability and durability of the components that MTC supplies are absolutely critical," explains Preben Jakobsen, Technical Manager, Grundfos. "Without that reassurance we would not be able to stand by our lifetime and performance guarantees, on which our reputation in the industry relies. In addition to the consistent supply of high quality components we are also delighted to have access to their materials expertise and state-of-the-art development facility, which are second to none."

During the relationship MTC has continually revised and expanded its production facilities at its site in Stourport, UK, investing significantly in

infrastructure and new processing technologies to ensure it can support both growing demand and the continued development of new innovative ceramic solutions.

A further expansion, which has been undertaken as part of the new contract, is scheduled for completion by the end of the year.

"We are extremely excited to be able to support Grundfos as it continues to push the boundaries of pump technology platforms, seeking new ways to increase performance and provide greater energy efficiency," explains Liam Shaw, Business Unit Manager, MTC Stourport. "By working in collaboration and providing materials development expertise from the start we ensure we meet our customers' requirements both today and in the future. Grundfos is a fantastic example of how successful that type of collaboration can be."



Gift presented to Grundfos to mark the celebration

## Developing Manufacturing Processes to Produce Alloys for Deep-Drilling Bits

Morgan Technical Ceramics Wesgo Metals (MTC Wesgo Metals) announced that it has developed a proprietary manufacturing process to focus on the production of high-strength, high-purity alloys for drill bits used in oil and fossil-fuel exploration. This streamlined manufacturing process for superior performance alloys supports the significant growth in deep drilling/fossil fuel markets, including potential increased demands from a proposed lift of bans on offshore drilling.

Stringent process control allows for highly controlled purity and consistent braze temperatures, resulting in alloys that exhibit high tolerance and a more reliable drill bit, as required for brazing Polycrystalline diamond cutters (PDC) to Tungsten. Increased tool life provides longer periods of uninterrupted drilling, increasing productivity and savings.

Reduced lead times and increased capacity not only satisfies increased demand for the specialized

brazing alloys utilized in these highly specialized drill bits, but also allows MTC Wesgo Metals to produce custom preforms according to customer specification. MTC Wesgo Metals is able to tool and stamp in-house, as well as offer materials in ductile foil form.

MTC Wesgo Metals' proprietary process for manufacturing high-purity alloys promotes superior performance in the field, offering increased tool life, productivity and cost savings.



## Diamonex Diamond-Like Carbon (DLC) Extending the Life of Fingerprint Scanners

Morgan Technical Ceramics Diamonex (MTC Diamonex) is working with leading fingerprint scanner experts to optimise its Diamonex® diamond-like carbon (DLC) coating for fingerprint recognition devices. Initial tests have shown that the Diamonex DLC coating can significantly extend the life of the scanners without sacrificing the precision of the sensitive device optics it is protecting. As a result, manufacturers will be able to offer products with greater reliability and significantly longer life.

Already widely used in medical, aerospace and automotive applications, and in retail scanners for over 15 years, the Diamonex DLC coating is an amorphous carbon material that displays some of the unique properties of diamond. By applying it as a coating the hardness, wear resistance and hydrophobic properties of the material can be passed on to different surfaces. The coating also has a slick, smooth feel, which reduces friction and repels dirt.

Traditionally, the fingerprint scanning areas of the devices have been constructed of relatively fragile silicon metal or plastic - making them susceptible to scratches and damage from other

environmental elements. This, in addition to the build up of finger print oils on the surface, often results in decreased precision and can lead to unit failure.

"Secure access biometric applications are becoming increasingly common and fingerprint recognition is a popular and, in most cases, cost effective solution," explains Brian Roznoy, General Manager MTC Diamonex. "The technology is becoming more pervasive, and penetrating a number of applications where damage to the sensor devices is a significant issue. Therefore the need for a robust coating to protect the devices from wear and tear and environmental abuse is growing."

The Diamonex DLC coating process produces a highly dense conformal finish with excellent adhesion. The DLC coating is typically a dielectric (non-conducting) layer, which means it can be built into the device structure as an active part of capacitance fingerprint sensors. For particular applications, the electrical properties of the Diamonex DLC coating can also be modified, e.g. to provide a level of static charge dissipation.

MTC Diamonex offers its unique DLC coating technology as a service coating option to customers that can ship their products to the



Allentown, PA facility in the United States. Alternatively, the company also offers complete DLC coating systems for sale, developed to meet specific customer needs, and backed by expert installation, training, and service staff. In either approach, MTC Diamonex application and development engineers work collaboratively with customers to develop or fine-tune the DLC coatings to deliver superior product performance.

## Decades of Experience with Nilcra™

Morgan Technical Ceramics (MTC) has been a world leader in the production of the strongest, toughest and most consistent Magnesia partially-stabilized Zirconia for over two decades. MTC's Nilcra PSZ is a ceramic alloy of high purity zirconium and magnesium oxides with a carefully controlled, unique microstructure.



This unique microstructure results in a material toughening mechanism called "Transformation Toughening," creating a combination of exceptional material properties. Nilcra PSZ was originally touted as the "ceramic steel," as it has comparable thermal expansion to that of steel. This attribute enables it to often be used as a direct replacement for hardened steel/metal alloy components.

MTC's Melbourne, Australia operation specializes in the manufacture of customized components manufactured from Nilcra PSZ. Zirconia ceramic solutions include applications and design input, prototyping and production capabilities to meet both low and high volume requirements. MTC Melbourne has the capability to manufacture Nilcra PSZ components up to 20" (500mm) in diameter and 24" (600mm) in length with cross sections up to 4" (100mm).

The company can machine to micron tolerances and super surface finishes, and boasts ISO 9002 accreditation.

Nilcra PSZ is available in two grades: Nilcra MS Grade PSZ for the majority of applications where maximum strength is required and Nilcra TS Grade PSZ for environments where higher thermal shock resistance is necessary.

## Showcasing Alumina Ceramics, MI20F and Macor® at Design-2-Part Show 2008

Morgan Technical Ceramics Wesgo/Duramic (MTC Wesgo/Duramic) showcased its Alumina Ceramics, MI20F Aluminum Silicate, and MACOR® Machinable Glass Ceramic material at the Design-2-Part Show at the Royal Plaza Trade Center in Marlborough, Massachusetts, November 5 - 6, 2008.

MTC Wesgo/Duramic showcased its alumina ceramics, which are custom fabricated to meet customer specifications in a variety of industries, including medical, aerospace, telecommunications and defense. The alumina ceramic materials range in purity from 94% alumina (AL-500) to 99.5% alumina (AL-995). For good wear resistance,

especially in applications involving the medical industry, MTC Wesgo/Duramic offers the 96% alumina (AL-600). For metallization of ceramics, 94% alumina (AL-500) and 97.6% alumina (AL-300) materials are offered, while the 99.5% alumina (AL-995) material is ideal for applications requiring chemical resistance.

Also exhibited was MI20F, a durable aluminum silicate ceramic based on natural lava, which is able to be machined into intricate shapes and held to very close dimensional tolerances. MI20F is an excellent choice for jigs and brazing fixtures, as well as for use in brazing, alloying, soldering, welding and glass sealing. Benefits include excellent chemical, oxidation and wear resistance, as well as superior thermal shock resistance and mechanical strength, with a high working temperature of up to 1150° C.

Additionally, MTC Wesgo/Duramic showcased MACOR, a Machinable Glass Ceramic material produced by Corning Inc. Widely used in aerospace, medical, welding and other industries and applications with high temperature, high vacuum, and high electrical resistance requirements, MACOR is quickly

and inexpensively machined into intricate and precision parts. These parts meet specifications with ordinary metal working tools, not costly diamond tools, and require no post firing after machining. MACOR is a registered trademark of Corning Incorporated, Corning, NY 14831. MTC Wesgo/Duramic is an approved distributor of MACOR.

MTC Wesgo/Duramic is the leading supplier of complex, precision engineered ceramic components for semiconductor, medical, vacuum, electrical and mechanical applications. The company is able to offer design assistance and customized solutions.

## Ignitor Assemblies for CO<sub>2</sub> Laser Industry

**Ceramic-to-metal assemblies offer several advantages, including better electrical properties, impact and thermal shock resistance.**

Morgan Technical Ceramics Alberox (MTC Alberox) announces its gas discharge igniter assemblies for carbon dioxide (CO<sub>2</sub>) lasers. CO<sub>2</sub> lasers are used for cutting plastic, fabrics and glass, as well as a wide-variety of marking, scribing and engraving applications. MTC Alberox provides the complete assembly, which includes a 99.5% high purity alumina igniter ceramic. High purity alumina is particularly well-suited for this application because it provides the required combination of dielectric properties, mechanical strength, and chemical stability. The igniter assemblies offer an ideal solution for igniting the plasma charge within the laser through a variety of methods. These methods include utilizing a radio frequency power supply or other high voltage power supply.

Fully-tested and with total materials traceability, MTC Alberox's igniter assemblies are manufactured using ceramic-to-metal seals, which offer several advantages over glass seals. Ceramic-to-metal assemblies have better electrical properties, impact and thermal shock resistance, as well as provide a more durable, mechanically stronger solution than ceramic-to-glass assemblies. Additionally, ceramic-to-metal seals are able to maintain hermeticity in a variety of harsh conditions, such as temperature extremes (up to 1000°C), corrosive, high pressure and high vacuum environments. Ceramic-to-metal seals employ brazing to join the ceramic and metal igniter assembly components, which produces a strong bond and an excellent seal.

With decades of experience manufacturing igniter assemblies, MTC Alberox's application engineering team is able to provide customers with the most efficient and reliable solution to fully meet their needs.

## Presenting Sharkskin™ Technology at 5th ISMI Symposium

Tim Dyer, Director of Technology at Morgan Technical Ceramics (MTC) Auburn and Hayward Ceramics presented the company's innovative Sharkskin™ technology at the 5th International SEMATECH Manufacturing Initiative (SMI) Symposium. The symposium was held on October 22, 2008 in Austin, Texas.

The presentation, titled "Integrating Texturing of High Purity Ceramics," introduced Sharkskin, a new technology that can significantly improve process residue adhesion, decrease process-related defects and increase yields during the manufacturing of integrated circuits. This technology is designed to replace traditional methods of roughening ceramic surfaces, such as grit blasting or twin-wire arc sprays, and involves the highly controlled texturing of the surface of ceramic components. This texturing does not contaminate or destroy the integrity of the surface of the part as grit blasting does; unlike arc sprays, it is an integral and indistinguishable part of the ceramic surface.

As Director of Technology for MTC's California businesses, Mr. Dyer is responsible for the direction of new product development, applications, machinery design and process improvements at these sites. Additionally, he supports production processes, intellectual property and new product solutions.

Having received a B.S. and M.S. in Materials Science and Engineering from the University of California, Davis, Mr. Dyer now holds 30 U.S. Patents in semiconductor equipment, manufacturing processes, plasma, materials, insulators, electrodes, polishing, electrostatic chucks and process integration. He has also authored eight papers and one textbook chapter on the subjects of ceramic materials, supply disruption, semiconductor manufacturing, materials synthesis, polishing/CMP, tribology and micro-contamination control.



## Haldenwanger adds OHSAS 18001 to its health and safety credentials

**Morgan Technical Ceramics Haldenwanger (MTC Haldenwanger), located in Waldkraiburg, Germany, has demonstrated its continued commitment to operational excellence by completing the OHSAS 18001 international occupational health and safety management system specification. The award follows the company's ISO 9001 and ISO 14001 accreditations, awarded in 1994 and 2005 respectively.**

The manufacturing and development site specialises in extrusion as well as utilising iso-pressing and slip casting to manufacture its products. These production capabilities enable the manufacture of more than 80,000 different highly complex industrial ceramic shapes, with dimensions ranging from 1mm to 4000mm. The components are then supplied to the global

thermal processing market.

The Occupational Health and Safety Assessment Series (OHSAS) audit procedure gives the site the tools to assess its processes and safety procedures against an internationally recognised standard. The Waldkraiburg site management team recognised that, despite the effort required, the certification had substantial benefits for them and, ultimately, their customers.

Joachim Mayer, Managing Director of MTC Haldenwanger explains, "This accreditation is not an industry or customer requirement, this was a proactive initiative from us to ensure our employees' safety. By reducing workplace risks we believe we can also empower employees to work more productively and, hopefully, reach their full potential."

Charlie Cobb, President, MTC Europe comments, "This certification reflects our organisation's commitment to implementing,

maintaining and, most importantly, continually improving its operational health and safety management systems. This commitment also ensures we continue to deliver the consistent quality of product that our customers rely on."



## GBC Materials Reach 50th Anniversary Milestone

**Morgan Technical Ceramics GBC Materials (MTC GBC Materials) has recently passed an important milestone with the celebration of its 50th anniversary. With five decades of experience, MTC GBC Materials boasts an impressive reputation in the industry for its high quality products and outstanding customer service. Today, MTC GBC Materials remains a leading manufacturer of high volume ceramic parts and glass products for a variety of industries.**

"We are extremely excited to have achieved such longevity in our industry," said Sharon Johnson, General Manager, MTC GBC Materials. "For us, this is an affirmation not only of the fact that we have exercised sound business principles and hired great people over the years, but also

that we have listened intently to our customers' needs. What's more, we have had management in place to ensure that, strategically, we are always moving in the right direction."

Founded in 1958, the company was originally named The Glass Beads Company before changing its name to GBC Materials in 1986. Throughout the years the company has carried on the tradition of manufacturing high-quality glass products and continues to manufacture glass preforms for glass-to-metal seal applications, but the main production output is now high volume, intricate pressed ceramic parts. These products serve a variety of markets, including digital electronics, telecommunications, HDTV, automotive electronic subassemblies, dual core microprocessors, home appliance, and aerospace.

MTC GBC Materials' industry achievements remain impressive. The company produces over 1 billion alumina components per year for the micro-electronics industry, and its glass preforms are critical components in military micro-electronics.



## Wesgo secures ISO-14001

**Morgan Technical Ceramics Wesgo Metals (MTC Wesgo Metals), announces that it has earned its ISO-14001 certifications. An international quality management standard, ISO-14001 certification encourages businesses to implement, maintain, and improve environmental management systems (EMS).**

"This is a logical step forward," said Mark Miklos, General Manager of MTC Wesgo Metals. "We have already demonstrated our environmental focus and capabilities by offering our customers high purity braze alloys. This certification further demonstrates and confirms MTC Wesgo Metals' commitment to utilizing environmentally sound materials. Also, despite increased operating costs and industry trends, MTC Wesgo Metals ensures product integrity by refusing to outsource alloy production to lower cost regions."

By manufacturing its products at its Hayward, California facilities, MTC Wesgo Metals maintains the highest quality standards and ensures the exclusion of contaminants such as lead, cadmium, zinc, fluxes and other corrosive chemicals.

"We decided long ago not to offer products containing these elements to prevent cross contamination. This way we can stay true to our core values in providing high purity, low vapor pressure braze alloys to industries where braze failure is not an option," said Miklos.

ISO-14001 requires compliance with a framework of environmental laws and regulations. As part of the certification, MTC Wesgo Metals will identify and control the

environmental impact of its manufacturing processes and end products, continually improve its environmental performance, and implement a systematic approach to setting and achieving its objectives and goals.

## High-Performance Edge Rings for Semiconductor Wafer Production

**Morgan Technical Ceramics CVD Materials' Silicon Carbide Material Gives Edge Rings Superior Thermal Conductivity and Purity.**

Morgan Technical Ceramics CVD Materials (MTC CVD Materials) offers high-performance, precision-machined Silicon Carbide (SiC) edge rings for Rapid Thermal Processing (RTP) applications, specifically semiconductor wafer manufacturing.

The superior quality of MTC's CVD Materials' edge rings, which hold the silicon wafer during processing, stems from the SiC used to produce

them. It is well known that SiC is the ideal choice for semiconductor equipment components due to its high thermal conductivity and resistance to abrasion, corrosion and erosion. Its ability to withstand constant and intensive use makes the material extremely reliable.

With its exceptional thermal properties, CVD SiC is an ideal material for RTP applications, as an intense heat pulse is applied to an individual wafer for a very short period of time. The heat is then turned off and the wafer is rapidly cooled. In a typical process, a wafer may be heated from 20°C to 1100°C in six to seven seconds and then cooled just as rapidly. MTC CVD Materials' edge rings can heat up and cool down much faster than the competition and not interfere with the heating and the cooling of the wafer. Further, CVD SiC has a low coefficient of thermal expansion (4.5x10<sup>-6</sup> °C from 20°C - 400°C).

CVD SiC also exhibits a high degree of purity, 99.999%, unlike sintered or hot pressed SiC where binders must be added. The high purity of MTC CVD Materials' edge rings minimizes the risk of wafer contamination during processing.

With its high resistance to wear and abrasion,

CVD SiC is a highly reliable, durable, non-particle generating material that is ideal for the ultra-clean environment of semiconductor manufacturing facilities. Additionally, with their resistance to corrosion, oxidation and chemical erosion, MTC CVD Materials' edge rings stand up to the plasmas and acids used in semiconductor processing and cleaning.



## Cores used in the Production of Gas Turbine Blades

**High Quality of Ceramic is Result of Superior Injection Molding Process.**

**Morgan Technical Ceramics Certech (MTC Certech) offers high-quality ceramic cores for the production of industrial gas turbine (IGT) blades.**

Within the industrial gas turbine industry, ceramic has emerged as the material of choice for a variety of reasons. Ceramic is capable of producing thin cross sections and holding tight tolerances which help produce accurate internal passageways in aerofoil and IGT castings. It is also strong enough to withstand the wax injection step used in the investment casting process. While the casting is being poured, the ceramic core remains stable, yet is readily leached using standard foundry practices once the casting has cooled.

The proprietary injection molding process used to create MTC Certech ceramic cores is superior to other core manufacturing techniques because it is much faster than competitive processes, allowing high volumes of cores to be manufactured in less time. Additionally, the ceramic material utilized by MTC Certech to make the cores has the added benefit of being less abrasive on the injection molds that are used, thereby increasing their lifespan. This translates to over 100,000 shipped cores per cavity, the most per cavity in the industry.

The result is a ceramic core that exhibits greater dimensional accuracy while maintaining tight



tolerances without distortion. Additionally, MTC Certech cores remain stable at higher temperatures and do not prematurely deform. This is an important consideration given the extremely high temperatures required for IGT component production. Further, MTC Certech's cores can be completely dissolved chemically after the casting has cooled, leaving the clean air

passage replica needed in today's efficient turbine engines.

As part of MTC Certech's injection molding technique, a thermo-plastic material is melted and mixed with ceramic powder. As the mixture cools, the casting is set, without abrasive wear and tear on the die, allowing more parts to be produced from a single die.