Morgan
Advanced Materials

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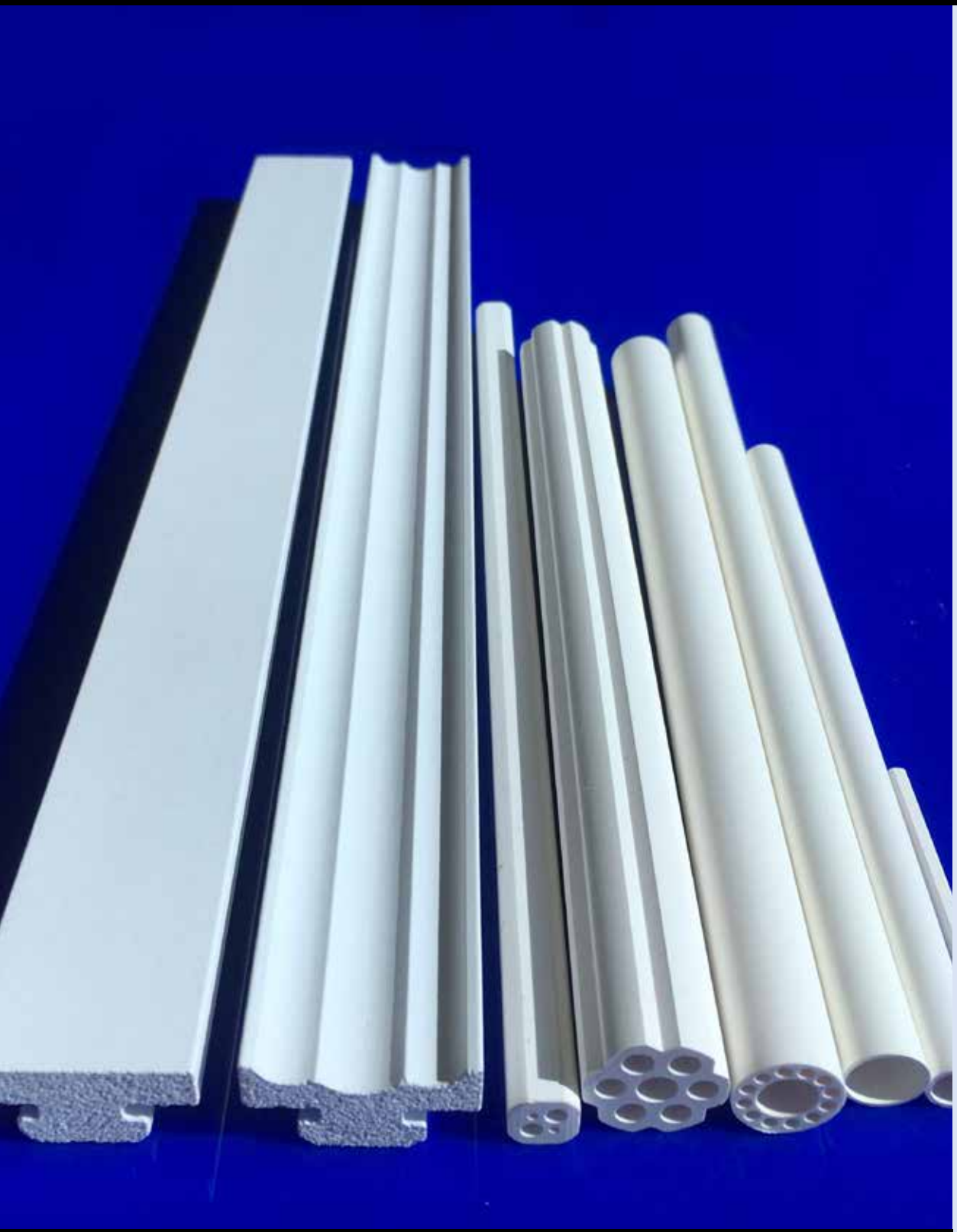
Advanced Thinking in Advanced Materials



NEWS RELEASE

Press Releases from October to December 2016

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Circular Economy initiative puts Morgan on the road to greater sustainability

OCTOBER 2016

The circular economy principles of re-use and recycle are enabling one global manufacturer to significantly improve its environmental health and safety targets, and turn waste furnace rock into new roads.

Morgan Advanced Materials, a global leader in the development and application of advanced material technologies, has revealed the results of some of its recent Environmental Health and Safety (EHS) activity which saw a major commitment to embracing circular economy initiatives across its global sites. As a result, the UK-headquartered manufacturer has enjoyed instances of a 50% reduction in chlorine use at one of its sites, a 23% saving in natural gas usage at a site, and a seven per cent global reduction of energy intensity across the group. This is in addition to the group achieving a five per cent reduction in water intensity and a one per cent reduction on waste intensity throughout 2015, when compared to the previous year.

Perhaps the most interesting example of a circular economy in action though, can be seen at one of Morgan's US sites, which is effectively facilitating the re-use of aggregate waste material into temporary road surfaces. The company's Georgia-based manufacturing facility, which specialises in Thermal Products for high temperature insulation, manufactures a range of products including insulating fibre, fire bricks and fired refractory shapes, which are used to manage heat and reduce energy usage in industries such as petrochemical, iron, steel, ceramics and cement production. The typical form of disposal for these materials is through landfill sites, but Morgan has been working closely with the local landfill operator to re-use the material to construct temporary road surfaces. These have replaced a number of gravel-coated roads in the landfill site. This programme has seen over 6000 tonnes of waste being diverted from general landfill.

The global EHS improvement plan is being led across the group by Morgan Advanced Materials CEO Pete Raby, in conjunction with the company's internal health and safety initiative, thinkSAFE. thinkSAFE is the Group's global safety performance improvement programme which is led top down by the CEO and the Executive team. This is supported by an online Intranet EHS resource for all Morgan employees, which has been translated into 17 different languages. The increase in health and safety standards across the group has resulted in fewer workplace accidents, an important achievement. By end of August 2016, the Group had achieved a 41% reduction in lost time accident frequency rate compared to the end of 2015.

Pete Raby, CEO at Morgan Advanced Materials commented: "The dilemma of how to deal with rising energy demand and materials waste will not be solved by one single solution, we need a combination of efforts. Energy efficiency improvements, clean energy initiatives and education to reduce consumption and re-use waste will all make a difference.

"At Morgan, we are driven by opportunities presented by megatrends and this is where our development in materials science and engineering plays a huge role to help other businesses reduce their environmental impact. We are working to continually improve our environmental health and safety standards across the group, enabling us to fulfil our mission to solve the engineering challenges of global industry, in the safest manner possible."

Morgan Brings its Acclaimed Range of hydrocyclones to new markets

OCTOBER 2016

Morgan Advanced Materials, a global specialist in the application of advanced material technologies for the Mining sector, is expanding its range of established hydrocyclone liners into new markets, as it continues to further develop this solution.

The existing hydrocyclone range is already used widely in the Oil and Gas sector. Now Morgan is growing its offering in a variety of industrial sectors, including pulp & paper, but also looking towards additional industries which face similar challenges when it comes to material separation in abrasive or corrosive conditions.

In mining applications, the lining of hydrocyclones in centrifugal separation systems can be subject to extreme levels of wear and tear as mining companies aim to separate valuable mined solids from unwanted, abrasive waste materials using hydrocyclone technology. Linings with low wear resistance erode quickly and require replacement, resulting in additional cost and excessive downtime. Ultimately, this leads to a decline in productivity, hence the requirement for robust linings which offer superior resistance to abrasion.

In order to withstand harsh environments, Morgan's liners are made using a proprietary alumina ceramic grade, specially formulated for high wear resistance, making them suitable for a host of applications which are subject to sustained contact with abrasive materials. In addition to the high quality base material, Morgan's glaze bonding technology facilitates high strength joining of liner components which enable the use of internal flow geometries while minimising risk of joint breakage, giving a longer overall lifespan, while reducing both total cost of ownership and downtime compared to other material solutions.

Morgan's growth in this product line is being backed by improvements to its engineering team. By investing in its process engineering and prototyping and development capability, Morgan can continue to deliver a hydrocyclone liner that is truly best in class.

Oliver Ridd, Commercial Manager at Morgan Advanced Materials, discusses the reasoning behind the development: "By investing in our engineering capability, this greatly enhances our ability to bring to market robust and reliable components suitable for harsh environments. Over time, increased investment will enhance our materials and product development capability, allowing us to better meet the engineering challenges of global industry."

Breakthrough from Morgan Offers Oil and Gas Boost

OCTOBER 2016

Businesses affected by the declining oil and gas markets can now access extruded parts which are higher performing and more complex than many alternative options, thanks to Morgan Advanced Materials, a global leader in the development and application of advanced material technologies.

Morgan has announced new developments in its range of extruded materials, which can now achieve more complex geometries to satisfy increasingly challenging requirements. The extrusion range has been developed in close collaboration with Morgan's global customer base over the last three years, in order to push the boundaries of the rheology of materials to new levels. The result is a range of materials and products which offer increased reliability, extended service life and reduced operating costs.

The oil and gas market has been facing decline since 2014, forcing businesses in the sector to change the way their products perform, bringing increased demand for more complex, higher performing designs in order to increase the longevity of components. Morgan, which has been using advanced ceramic materials to produce extruded parts for use in temperature measurement and other industrial heating products for over 40 years, has applied its extensive knowledge of design and material performance to develop new complex components which satisfy this demand.

Morgan's standard range of extruded products are made from grades of Magnesium Oxide, Alumina, Silica and Hafnia, materials which have strong insulating properties and thermal conductivity. The new range of extruded products from Morgan enhances this capacity, and further controls density, strength, and particle size distribution to meet exact customer specifications.

Grahame Pulford, Product Development Engineer at Morgan Advanced Materials commented: "At Morgan we are committed to working in partnership with our customers to continue to push the boundaries of material and geometry design, in particular for use within challenging environments. Our new range of extruded products will significantly enhance performance, enabling our customers to remain competitive in a highly volatile market."

Morgan Expands Silicon Carbide Production Capability To Meet European Demand

OCTOBER 2016

Morgan Advanced Materials, a global leader in the development and application of advanced material technologies, now has a dedicated volume silicon carbide manufacturing facility in Stourport, UK. This increased capacity has enabled the company to augment its sales in Europe and worldwide with these higher performing silicon carbide materials.

Morgan is able to produce both sintered silicon carbide (PS5000 - SiC) and graphite loaded (PGS3 – SiC) silicon carbide materials primarily for mechanical seals and radial bearings. These products are used in domestic water pumps, heavy duty industrial water, and chemical pump applications, including cooling pumps for plastic injection moulding machines.

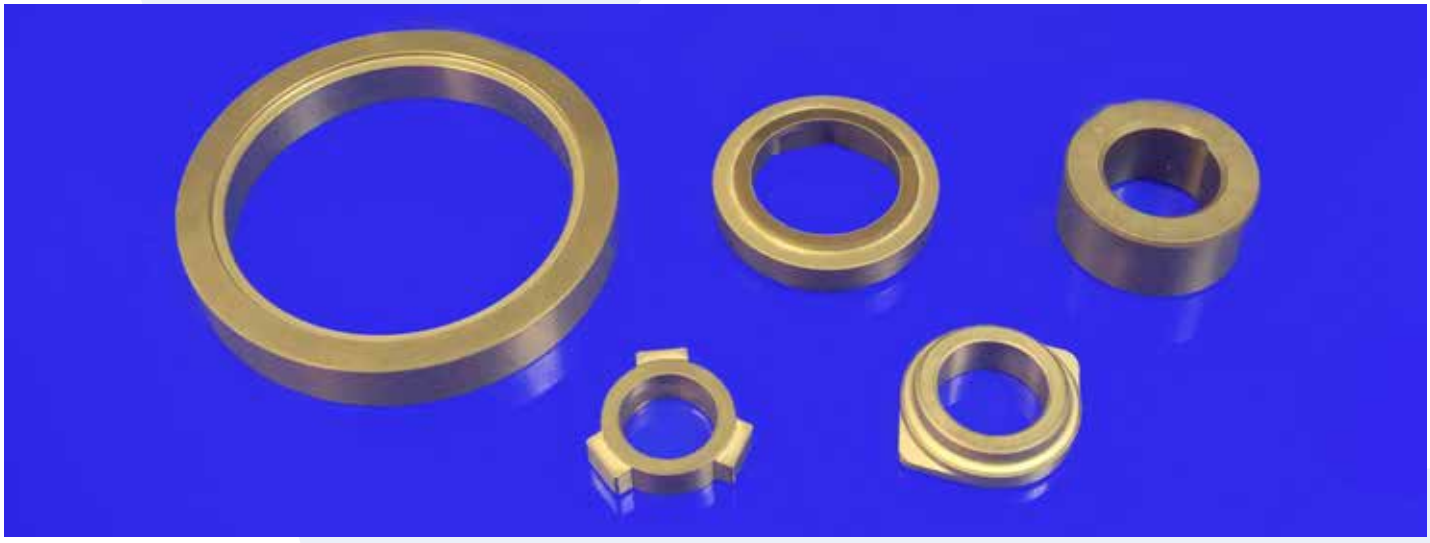
Global demand for silicon carbide in pump designs is soaring, largely as a result of the technical and cost benefits this ceramic grade can provide over other materials such as tungsten carbide and alumina. Morgan's silicon carbide ceramics continue to give high performance when pumping contaminated, abrasive and corrosive fluids and provide excellent sealing at high pressures. They have a low thermal expansion coefficient and high thermal conductivity which contributes to its outstanding thermal shock resistance; this is particularly important if pumps have a risk of running dry. Overall pump reliability is increased and as a result companies experience less downtime, resulting in reduced operational costs.

The move to increase the silicon carbide manufacturing capability is a natural progression for Morgan, which has been manufacturing alumina ceramics for pump applications for the last 50 years. The company has recently completed investment in new kiln and manufacturing equipment, capable of firing and processing high volume silicon carbide products through a dedicated cell. This has enabled Morgan to form near press-to-size silicon carbide components up to 80mm (3.15 inches) in diameter, with detailed design features and precision dimensional tolerances.

The addition of graphite loaded silicon carbide material to Morgan's range enables the business to help its customers to improve dry running performance in pump seals, as well as reducing the risk of seals failing in operation. Mechanical seals are an essential part of many pump systems in sealing the rotating motor shaft from the pumping fluid; they trap a thin film of liquid, which acts as both a lubricant and a seal. However, these pumps sometimes continue to run when there is no fluid present, resulting in increased friction and higher operating temperatures, which can cause the adjacent O-ring to degrade, and the seals to leak. The low thermal expansion efficient of graphite loaded silicon carbide, together with its high thermal conductivity, provides greater protection in these circumstances.

Chris Paine, Business Development Manager at Morgan Advanced Materials, commented: "This extensive investment enables us to offer seamless production of silicon carbide seal and bearing products, from raw materials to finished parts manufacture at one single site. This means that we can provide the requisite quality assurance for all our products while responding to global demand for high volume manufacturing capabilities.

"Silicon carbide is already a proven material for heavy duty pump products, providing greater wear resistance and improved performance over alternative materials. We are continuing to invest in our facility, and our research and development, to ensure we can continue to provide solutions to meet the engineering problems faced by customers."



LASA Ballistic Shields from Morgan Pass NIJ Testing Standards at Independent Test Centre

OCTOBER 2016

Morgan Advanced Materials' LASA Ballistic Shields have successfully passed ballistics testing in accordance with NIJ 0108.01 against NIJ Level III and special rifle threats.

The full NIJ compliant testing was carried out by Chesapeake Testing at an independent centre in the USA. The LASA ballistic shields were successfully tested against three different rifle rounds: 7.62x51mm M80 Ball, 7.62x39mm M67 (PS Ball) and 7.62x39mm M43 (PS Ball).

Passing the rigorous testing is testament to the performance of Morgan's LASA Ballistic Shields, which deliver outstanding multi-hit rifle protection and an extreme low weight. With a thickness of just 16mm (0.6 inches) and an areal weight of just 16.0 kg/m2 (3.28 psf), Morgan's LASA Ballistic Shields are 20% lighter than existing in-service solutions and allow for increased mobility and endurance.

Chris Davies, Technical Director of Composites and Defence Systems at Morgan Advanced Materials commented: "Successful completion of stringent NIJ 0108.01 testing demonstrates the outstanding performance of our LASA Ballistic Shields against a wide range of relevant threats. Our materials research and development coupled with our processing expertise and extensive product testing have allowed us to develop an ultra-lightweight ballistic shield that meets the needs of modern law enforcement and military personnel."

Morgan's LASA Ballistic Shields are available in four standard sizes, with bespoke shaped solutions also available for larger volumes. The range is available to buy from Morgan Composites and Defence Systems in Canada, UK and Singapore.

Morgan Announces Ceramic Acoustic Reflector Manufacturing Capability for Flow Metering

OCTOBER 2016

Morgan has developed the capability to produce complex ceramic acoustic reflectors used in ultrasonic flow meters, drawing on pioneering research carried out in conjunction with Loughborough University, ensuring consistent measurement accuracy over a longer projected lifespan.

Ultrasonic flow meters commonly used in residential utilities measurement, play an important role in providing accurate monitoring and flow control. A growing demand for increased measurement accuracy has fueled a surge in the use of ultrasonic technology in flow metering. Central to this technology are acoustic reflectors, which are used in flow tubes to convey ultrasonic waves from one sensor to the other. Historically, these have generally been made from stainless steel however recent developments between Morgan and some of its key customers in the flow sensing market have led to the development of ceramic reflectors, offering a number of performance advantages.

While stainless steel acoustic reflectors initially offer greater measurement accuracy, this has been found to decline over a number of years. Conversely, ceramic wedges made using proprietary Alumina from Morgan do not experience a comparable decline, offering greater measurement accuracy over the long term. After a period of 10 years, the gap in performance between ceramic and stainless steel reflectors noticeably widens. Morgan is able to provide high sensitivity and wide bandwidth ultrasonic sensors for flow measurement, to increase this starting sensitivity further.

Morgan's ceramic acoustic reflectors offer a variety of additional benefits over their stainless steel counterparts, the inert properties of the material make it safer in water processing while its lightweight composition reduces the overall weight of components without compromising on durability. Other benefits include improved surface smoothness and scale thickness, both of which enhance the accuracy of meter readings.

Drawing on its vast experience in application engineering, Morgan has discovered a pioneering approach to developing ceramic reflectors using injection molding technology, meaning it can now accommodate a wider range of bespoke designs with complex geometries to meet the requirements of industry. This method also allows Morgan to tune the sensors to the correct beam width and acoustic properties, ensuring maximum sensitivity by potentially reducing the turbulence of the water flow path around wedges. This is done by creating more complex shapes that can aid the fluid dynamics of the flow in the tube.

Charles Dowling, Business Manager at Morgan commented: "This development is the outcome of a unique collaboration between Morgan and Loughborough University and is a clear example of where we have pushed the boundaries to provide complete solutions for our customers. Longevity is a challenge for many of our customers in industrial metering and we have optimised our ultrasonic sensors to deliver sustained performance over time compared to other materials.

Morgan Announces 2-In-1 Encoder and Slip Ring System For The Construction Industry

OCTOBER 2016

Morgan Advanced Materials, a global specialist in world leading rotary transfer systems, has announced the launch of its 2-in-1 encoder and slip ring system for high reaching earth moving plant and cranes.

By internally assembling a highly sensitive, miniaturised encoder within the mechanical slip ring system, Morgan has created an easy-to-install component which is compatible with existing systems and allows for the accurate transmission of data from machine to driver.

As the construction industry continues to move in favour of data-driven safety and working assistance intelligence, Morgan has once again risen to the challenge of developing products which answer the real problems faced by customers in its key markets. In this instance, the conventional slip ring has been re-designed to include a fully integrated Hall encoder.

Using high level, in-vehicle communications networks, the encoder indicates the angle position of the upper structure in relation to the plant's undercarriage, transferring the information into a CANopen protocol which is retrievable by the driver or the working assistance controller.

By combining a hall encoder (which works in response to a magnetic field) with Morgan's heavy duty slip rings, available in a variety of materials including stainless steel, aluminium and UV-resistant plastic, the world renowned manufacturer has brought to market a 2-in-1 solution which can be tailored to the exacting system requirements of each customer, whether the plant is new or already in service.

The design of this latest component also takes into consideration the future requirements of the construction industry, ensuring the plant is ready for the advent of automated 'self-working' construction equipment.

While the encoders may be very small, they can be customised to suit the communications requirements of any high-reaching machinery, with a range of different interfaces, as well as adaptable output signals including full redundant or data variants.

Christoph Daun, Technical Sales Engineer for Morgan's Electrical Carbon business comments on the development of the 2-in-1 encoder and slip ring system:

"Like many sectors, the construction industry is moving in favour of telemetry, remote controlled or pre-programmed machinery and intelligent in-vehicle communications systems which can enhance driver and site safety.

"Morgan's new 2-in-1 encoder and slip ring system is highly flexible when it comes to retrofitting in-service plant, with a number of customisable signalling and transmission options available to suit any pre-existing system.

"We are committed to developing components which solve real industry challenges, not just now but also in the future. By creating a heavy-duty slip ring with an encoder built in, we are offering OEMs and equipment owners the chance to install a component which not only meets their in-vehicle safety monitoring requirements now, but can also support during the future changes of automated self-driving machinery."

Morgan manufactures slip rings for the construction market which range in current from milli-Amp to 1000Amp and a voltage from milli-Voltage up to 10.000V. These slip rings can then transfer data via Fast Ethernet at a rate of up to 100Mbit/sec.

Morgan Advanced Materials Launches New Ultra-Lightweight Level III Standalone Ballistic Insert

OCTOBER 2016

An ultra-lightweight, high performance standalone ballistic insert, protecting against NIJ 0101.06 Level III and special rifle threats has been launched by Morgan Advanced Materials.

Morgan's new 'LASA LWB III+ sa06' ballistic insert is a multi-hit standalone solution, which does not require additional soft armour. It has been tested in accordance with NIJ 0101.06 against 7.62 x 51mm 149gr M80 FMJ and the special threats; 5.56 x 45mm 55gr Ball (M193) and 7.62 x 39mm 123gr AK47 MSC (Mild Steel Core). The ballistic insert is buoyant resilient, making it ideal for both maritime environments and land operations. Furthermore, it meets stringent drop test requirements as stated in the NIJ 0101.06 specification.

With an areal density of just 14.9 kg/m^2 (3.05psf), a medium ballistic plate weighs just 1.0kg (2.3lbs). It is available in five sizes, delivering a customised fit to a wide range of users. The ballistic insert's lightweight properties allow for superior mobility and lower weight burden whilst ensuring ballistic protection from NIJ Level III and special rifle threats.

Duncan Eldridge, President of Morgan's Composites and Defence business, stated: "The LASA LWB III+ sa06 ballistic insert is our lightest standalone solution for NIJ Level III and special threats. It has been developed as a result of our use of cutting-edge materials and extensive research and development, which has enabled us to produce a product which is considerably lighter than alternative solutions. Its buoyant properties also make it ideal for use in maritime environments whilst delivering lightweight, high level protection".

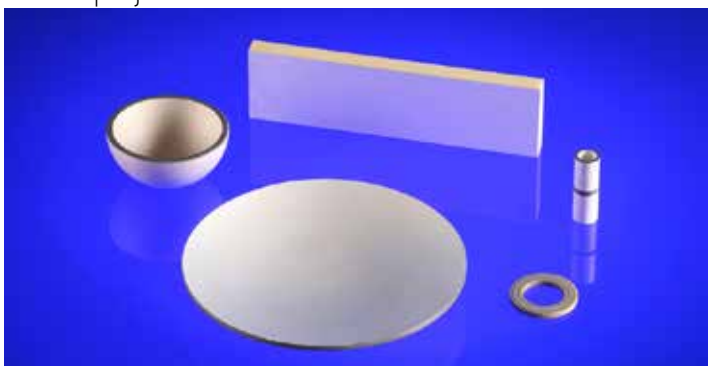
The ballistic insert is the latest addition to Morgan's wider suite of LASA soldier protection products, which includes covert solutions for undercover operations, protection against NIJ Level III, special threats such as SS109 "Green Tip" ammunition, and special threats exceeding NIJ Level IV. All ballistic inserts are available for purchase through Morgan's Composites and Defence Systems business in the UK, Canada and Singapore as well as through its global distribution network

Growth Within the Global Maritime Security Sector Gives Boost to Morgan

NOVEMBER 2016

As new threats in major oceans around the world continue to emerge, Morgan Advanced Materials has improved its production and design capability for piezoelectric ceramic (PZT) components and transducers used for underwater SONAR applications.

Morgan is now able to offer a range of solutions which can be customised in terms of size, materials and sonar frequency to meet the technical demands of any underwater application. Its PZT component and transducer range offers solutions for active and passive systems, covering the full range of Navy Type I, II, III, VI, and other custom formulations. Morgan also has the prototyping capability and technical expertise to assist customers throughout the development and implementation of new projects.



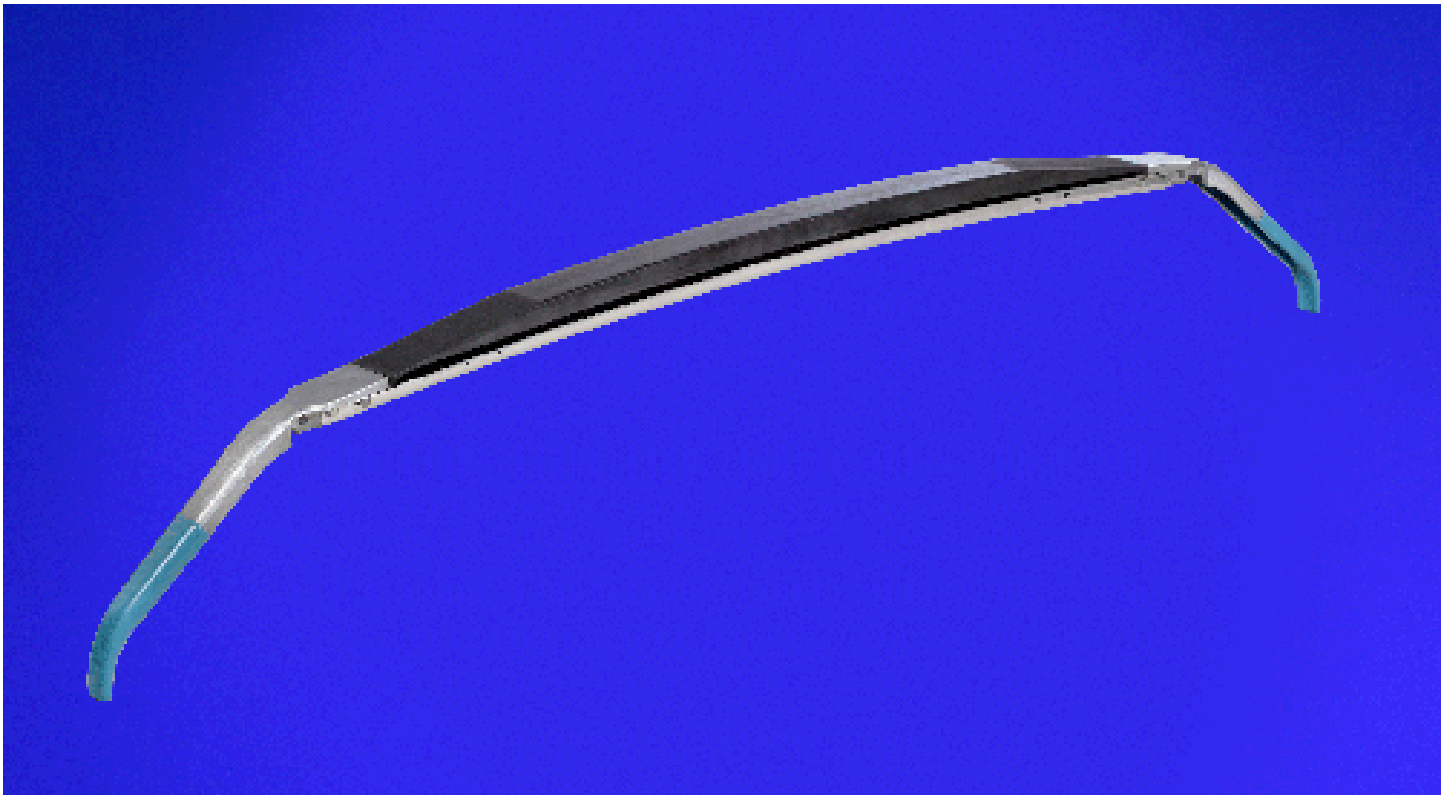
The move comes at a time when forecasts indicate that the maritime safety sector will grow at an estimated Compound Annual Growth Rate (CAGR) of 7.2% until 2021 .This prediction was reinforced by a recent statement from the Ministry of Defence, which has pledged to invest £1.9 billion in a project to prepare a national defence system to combat stealth submarines in British waters.

With security still of critical importance for the UK/US (amend as applicable when issuing) government, more advanced technologies are being used in the fight against an increasingly sophisticated range of maritime threats. This has seen a significant upscaling of maritime security efforts including increased investment in SONAR systems and technology based on PZT components.

Paul Turnbull, Sales and Business Development Manager at Morgan Advanced Materials, explained: "With heightened demand for maritime security solutions, Morgan Advanced Materials is in a strong position to supply vital components which are used in SONAR applications. We can offer PZT components in a range of formulations and have the capacity and capability to meet demand in the US, UK, and other nations."

Morgan Doubles Service Life of China's High Speed Rail Network

NOVEMBER 2016



The service life of China's world leading high speed rail network has been successfully doubled with the application of electrical current collectors from Morgan Advanced Materials.

Morgan's plain carbon strips and metallised collector strips have delivered a marked increase in service life when compared with alternative methods, and passed on a significant reduction in the operation and cost of the high-speed railway. The products, which are in operation in China, now have potential to be used in a number of metro lines and high speed rail networks across the globe, delivering improved service life even during difficult weather conditions.

The strips offer a long-lasting alternative to the carbon traditionally used in rigid catenary systems, which is prone to wear from electric sparks and arcs, typically resulting in a limited service life. Morgan's products utilise a customised airway system within the carbon strip, which meets the demanding requirements of current collectors, with the right trigger sensitivity. Self-supporting, the strips have been proven to reduce pan head mass and improve dynamic response, helping to lower the costs associated with operation and maintenance. Similarly, because the products are specially engineered from Morgan's advanced carbon material, they increase the service life of the carbon strip in high temperatures, dry conditions, and even the most challenging wet and humid environments.

This is of particular interest to China, which has the world's longest high speed rail network. China's network was used by approximately 1.1 billion people in 2015, making it the most heavily used in the world. For such a busy railway, high performance is critical, as any maintenance or downtime required on the track can lead to major disruption.

Morgan's collector design has already gained approval by the EMU OEM of China Railway Rolling Stock Corporation (CRRC), as well as being certified by the China Railway Certification Centre. The strips are a product of extensive research and development from Morgan, as it successfully developed a product with stronger electric wear resistance, even when the current capacity remains almost unchanged.

Boris Jaing, Managing Director of Morgan's Electrical Carbon Business in Asia commented: "Every day a huge number of Electrical Multiple Units (EMUs) are running on a railway of 19,000 kilometres across China, covering various climates and geographical conditions. This poses challenges for the safety, reliability and on-time operation of the network, as well as driving up operation and maintenance costs. Our plain carbon and metallised collector strips leverage Morgan's strengths in the material, design and application of current collectors and are poised to play a key role in improving the service life of high speed rail networks all over the world."

Morgan Advanced Materials Boosts Grinding Capability for Greater Pump Efficiency

NOVEMBER 2016

As design engineers increasingly seek out more efficient, higher performing pump components, Morgan Advanced Materials has improved its grinding capability of technical ceramics, in order to machine parts to single-digit micron tolerance.

Morgan Advanced Materials, a global leader in the development and application of advanced material technologies, has transitioned its process capabilities in response to meet growing customer demand for improved tolerances on shafts and bearings, specifically for pump applications. The result is a more energy efficient, higher performing pump with reduced wear, improved friction, and lower running noise. This is made possible through the use of Morgan's state-of-the-art precision grinding technology, which the company continues to invest in.

Morgan has long advocated the use of technical ceramics over traditional materials to enhance the operational efficiency of rotor assembly in pumps. Efficiency and longevity, which are increasingly becoming more critical considerations where pump applications are concerned, can be realised through the use of Morgan's world leading shafts, bearings and seal components. Not only can technical ceramics such as alumina and silicon carbide be formulated and fired into exceptional wear and corrosion resistant components, but they can also be manufactured in a variety of precision geometries.

With the growing demand to miniaturise high specification electric pumps, smaller shafts and bearings with tighter tolerances are becoming a crucial part of pump design. By achieving tighter tolerances, Morgan is helping to deliver more efficient pumps for applications in sectors including automotive, home appliances, energy, and beverage.

Chris Paine, Business Development Manager at Morgan Advanced Materials, commented: "The drive to make pumps more efficient and durable is leading manufacturers to look at every element of the design and manufacturing process to see where improvements can be made. Morgan's direct involvement with pump customers and their design engineers has enabled optimisation of new pump designs in terms of energy and environmental efficiencies over a range of domestic, industrial and automotive pump applications."

Morgan Announces Prototype Capability for Custom Piezoceramic Microtubes

DECEMBER 2016

Morgan Advanced Materials has become one of the first materials specialists globally to offer a prototype and development service for piezoceramic microtube components in diameters between 0.4mm to 1.0mm, and lengths of up to 15mm.

The products have been developed following increasing demand for ever smaller piezoelectric components, brought about by the accelerated rate of technological innovation in markets including medical, industrial measurement, and consumer electronics. In certain applications where there is a need to accommodate optical fibres or ultrasound probes, components must be of a specific size to ensure compatibility. Attempts to produce components of this size which meet the performance demands of their intended applications have, until now, proven difficult due to the sheer intricacy of the geometries required and the materials used. This breakthrough from Morgan makes it the only international supplier that can produce Lead Zirconate Titanate (PZT) microtubes within these exact parameters.

In addition to the diameter of Morgan's piezoceramic microtubes, another aspect of the design which makes the company's offering unique is the fact that the range can be supplied to custom electrode configuration. Morgan's team of ceramic specialists have the capability to laser edge the components, splitting the surface into several external electrodes. This enables the component to bend during operation, opening the door to a variety of new applications.

Paul Turnbull, Sales & Business Development Manager at Morgan Advanced Materials, explained: "For a long time we have been leading the way in the design and manufacture of PZT ceramic components. Once again, we have worked hard to push the boundaries in order to meet the demands of the next generation of electrical components. Our commitment to finding custom solutions which address our customers' most pressing engineering challenges is what keeps us ahead of the game and constantly innovating."

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ABOUT MORGAN ADVANCED MATERIALS

Morgan Advanced Materials is a global engineering company offering world-leading competencies in materials science, specialist manufacturing and applications engineering.

We focus our resources on the delivery of products that help our customers to solve technically challenging Problems, enabling them to address global trends such as energy demand, advances in healthcare and environmental sustainability.

What differentiates us?

Advanced material science and processing capabilities. Extensive applications engineering experience. A strong history of innovation and reinvention. Consistent and reliable performance. A truly global footprint. We find and invest in the best people.

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