Advanced Solutions for the Energy Sector
Morgan Advanced Materials

Morgan Advanced Materials is a global materials engineering company which designs and manufactures a wide range of high specification products with extraordinary properties, across multiple sectors and geographies. From an extensive range of advanced materials we produce components, assemblies and systems that deliver significantly enhanced performance for our customers’ products and processes. Our engineered solutions are produced to very high tolerances and many are designed for use in extreme environments.

The Company thrives on breakthrough innovation. Our materials scientists and applications engineers work in close collaboration with customers to create outstanding, highly differentiated products that perform more efficiently, more reliably and for longer.

Morgan Advanced Materials has a global presence with more than 9,000 employees across 50 countries serving specialist markets in the energy, transportation, healthcare, electronics, security and defence, petrochemical and industrial sectors. It is listed on the London Stock Exchange in the engineering sector (ticker MGAM).

About our Energy business

Morgan Advanced Materials develops products for power generation and distribution from renewable and traditional sources. We also supply a range of insulation products that provide heat management solutions. Our materials and products have a strong reputation for performance and reliability in the energy sector, built on years of experience supplying products across the electricity supply chain.

We continue to work at the heart of this evolving sector developing components and subassemblies for generators, distributors and users of energy from traditional and renewable sources. We are involved in many and diverse energy-related projects from piezoceramics for energy harvesting technologies to high quality capacitance for high voltage systems.

Increasingly, our materials technology is employed to allow more efficient use of energy by reducing friction, providing better insulation and enabling new technologies.

Our patented silicon carbides and graphite composites are specifically designed to reduce friction for better reliability and energy efficiency. Our advanced insulation materials are used to enhance the purity of silicon for solar cell production.

Typical applications for our products include

- BOILER CASINGS
- BRUSHES FOR ELECTRIC MOTORS
- CABLE INSULATORS
- FUEL CELL COMPONENTS
- GAS METERS
- HRSG STACKS
- INDUSTRIAL GAS TURBINES
- LIVE LINE INDICATORS
- NUCLEAR REACTORS
- OIL WELL SUBMERSIBLE PUMPS
- POLYCRYSTALLINE SILICON GROWTH
- SOLAR PANEL MANUFACTURE
- WATER METERS
- WIND TURBINES
INCREASING POWER AND SUSTAINABILITY IN THE ENERGY SECTOR
Renewable Energy - Solar

Morgan Advanced Materials designs and manufactures a range of products for the global solar market helping to improve the manufacturing process and enhance the performance of the end product. From silica fused rollers and high-purity ceramic lifting bars used during the solar panel manufacturing process, to our Superwool® HT VF insulation products with advanced solar treatment offering superior energy and light reflection ratings used to insulate the reflectors in solar collection towers. Our high-specification insulation materials are also used to control the silicon melting process, optimising energy efficiency and reducing contamination, for more efficient photovoltaics.

Processes
- CHEMICAL VAPOUR DEPOSITION (CVD)
- PHYSICAL VAPOUR DEPOSITION (PVD)
- THIN-FILM PROCESSES (CIGS, CDTE, CIS etc.)
- STRING-RIBBON SILICON SOLAR CELLS
- IN-LINE OR BATCH DOPING OF WAFERS

Applications include
- VAPOUR DEPOSITION REACTORS / CONVERTERS
- CVD SIC & PBN COATED GRAPHITE HEATERS
- DSS-FURNACE & CZ-FURNACES
- TEMPERATURE MEASUREMENT MONITORING
- DIFFUSION-FURNACES
- PBN FREE-STANDING PARTS
- THIN FILM
- WAFER HANDLING
- WAFER SAWING
Our products are helping improve global solar panel production.
Thermocouples

Morgan Advanced Materials has a wide range of different materials for thermocouples used for temperature measurement. Alumina, Mullite, Silicon Carbide or Zirconia tubes are available in standard and non-standard designs. Our materials are inert preventing contaminants and the range of materials means we can provide customised solutions for our customers. Our tubes deliver optimal solutions for applications up to 2000°C (3632°F) in aggressive mediums as well as in alternating thermal stress loads.

Insulating Products

High purity ceramics, such as Alumina (A1995 Alsint 99.7), Silicon Carbide, Mullite or Zirconia MgO-PSZ, which are resistant to temperatures, have excellent electrical insulating properties and in the case of Silicon Nitride, a resistivity to highly corrosive atmospheres while maintaining the high strength capabilities of the material. Pyrolytic Boron Nitride (PBN) exhibits a resistivity of 10^7 to 10^9 ohm.cm at 1000°C (1832°F) with virtually no outgassing, making it an ideal insulator in vacuum applications.

Crucibles and Boats

Our custom performance Pyrolytic Boron Nitride (PBN) crucibles allow CIGS PV Solution providers the ability to vapour deposit thin films rapidly. Performance PBN is inert, has low wetting to alloys and is resistant to thermal shock. We also provide Silicon Nitride which is ideal for use in crucibles and refractory’s for the production of high purity Silicon, plus Fused Silica and Alumina crucibles which are used in processes such as heat treatment, Silicon manufacturing and crystal growing.
**Ceramic Rollers**

Thermal processing of Silicon wafers and module glass can benefit from our Fused Silica rollers. These rollers are inert, with high mechanical strength and a good wear characteristics leading to a long life in a challenging high temperature environment. For high temperature applications in aggressive atmospheres we have developed our new HalSolar-rollers. They stand out due to their chemical resistance, excellent thermal shock resistance and smooth surface.

**Ceramic Bars and Locator Pins**

Large, high precision, high purity ceramic bars and locator pins for lifting, stacking and aligning glass panels in PVD processing and annealing, provide a superior solution to stainless steel lifters. Our ceramic pins are used as locators and separators between key components inside the PVD reaction module chamber. Our high purity Alumina formulations provide higher strength at elevated temperatures and eliminate buckling associated with metal solutions. Improved chemical stability eliminates contamination on the surface of the glass in processing environments.
Renewable Energy - Wind

Morgan has a long history of producing products to improve the efficiency and reliability of wind energy technologies reducing friction and enabling components to face the harshest of environments. Our materials and products including advanced composites, carbon brushes and rotary transfer systems for wind turbines used by some of the world’s leading companies are helping them reduce down time and associated maintenance costs. By working in partnership with our customers we ensure the best solution is developed for even the most challenging of applications.

Typical Products

- CARBON BRUSHES
- SLIP RING TRANSMITTERS
- POWER SLIP RINGS
- HUB CONTROL SLIP RINGS
- ROTARY TRANSFER SYSTEMS
- WIND BRUSHES
- PITCH CONTROLS
- LIGHTENING PROTECTORS
- ANEMOMETER
- SLIP RINGS
- FIREMASTER® (FIRE PROTECTION RANGE)

Applications include

- DATA TRANSMISSION
- FIRE PROTECTION
- LIGHTENING PROTECTION
- POWER GENERATION
- EARTHING
OUR PRODUCTS ARE CAPABLE OF PROVIDING UP TO 200 MILLION ROTATIONS OR OVER 20 YEARS SERVICE
Product Highlights

Rotary Transfer Systems for Wind Turbines
Morgan Advanced Materials designs and manufacturers a wide range of compact, lightweight, high reliability power generation systems with slip rings, carbon brushes and holders and high performance rotary transfer systems for reliable data transmission in challenging conditions ideal for use in wind turbines, for power generation, pitch control, lightning protection and earthing systems.

Our highly engineered solutions are designed to optimise generator performance for virtually any type of climate helping extend brush life, protect slip-ring surfaces and reduced friction.

Hub Control Slip Rings
Our market leading products, sold under our Rekofa brand, have been developed through decades of experience in global markets. Depending on customer requirements, each modular system includes either advanced slip rings, wire systems, metal contacts, metal-graphite brushes or other components engineered to suit any wind application.

Key Features and Benefits
- A LIFETIME OF UP TO 20 YEARS OR 200 MILLION ROTATIONS
- UP TO 5 YEARS FREE MAINTENANCE AND LUBRICATION
- DATA TRANSMISSION CAPACITY UP TO 400MBIT/S
- SHOCK AND VIBRATION RESISTANCE
- HYBRID SYSTEMS UTILISING WIRE SYSTEMS AND METAL-GRAHITE BRUSHES
- FIBRE OPTIC ROTARY JOINTS UP TO 1GBIT/S

Our systems incorporate
- ROBUST AND WATERPROOF CASING
- SLIP RINGS FOR HIGH CURRENT AS WELL AS DATA SIGNALS
- PLUG-IN COUPLING FOR EASY ASSEMBLY
- SLIP RING CONNECTIVITY
Morgan offers a complete brush, holder and slip ring system for wind power generation and have optimised this system, combining improved brush holder design, high performance brushes and slip rings designed to meet the needs of specific applications.

**Carbon Brushes**

Our range of carbon brushes provide exceptional performance from no-load to high-load for a range of applications including; power generation, non-drive end earthing and lightening dissipation. Key benefits include low friction through extreme atmospheric conditions and low humidity and reduced brush-to-brush wear differential.

Available in a range of materials including; copper, silver, electro and natural graphites, they offer contamination tolerance and are engineered for specific applications to reduce slip ring wear and maximise brush life.

**Brush Holders**

We offer standard and upgraded holders, bus bars, spindles and high end design, from constant force springs providing stable pressure over time, various platings for atmospheric protection, brush wear alarm indicators to plug and play ease of fitment.

**Power Slip Rings**

Our high performance power slip rings can be designed to meet the needs of specific applications; available in steel, stainless steel, bronze or cupro-nickel. Their cost efficient design is tested for high potential, over-speed and extreme temperature capabilities, they thrive in extreme environments. Our slip rings are provided with brush holders and mounting cage assemblies.
Hydroelectric Power

Our Seals and Bearing business produces high quality wear components used in hydroelectric power generation applications. Our carbon turbine glands are highly-specialised and created in association and collaboration with prominent turbine constructors worldwide; we have supplied glands for shaft diameters up to 1350mm (53.15”). There is currently no known material proved to be superior to carbon for turbine glands.

Key benefits

- HIGH RELIABILITY
- EASY TO INSTALL
- REDUCED DAMAGE/WEAR TO TURBINE SHAFTS
- LOW MAINTENANCE AS THEY DO NOT REQUIRE FREQUENT ADJUSTMENT
Energy Storage - Renewable fuel cell components

Morgan’s expertise in highly-engineered ceramic formulations and manufacturing processes are supporting advances in storage for renewable energy devices such as fuel cells. Our Sintox™ FA material is specifically specified for this application due to its excellent bond strength for metallisation and resistance to chemical attack, both vital factors for ensuring batteries continue to perform consistently during their lifetime.

We manufacture a range of critical components and technology solutions used in cutting edge renewable energy storage technologies. Working with some of the world’s leading brands our components are designed to provide safer, more efficient and cost-effective energy storage, distribution and utilisation. Our products are used in battery modules to build complete energy storage solutions for the telecom, energy management, power generation, grid operation, back-up and motive power industries.

Thermal Insulation for fuel cell applications

Our WDS® microporous thermal insulation is successfully used in SOFC or PAFC as cell insulation. Featuring low thermal conductivity (<0.005W/mK at 10Pa) and absolute thermal shock resistance and flexibility in shapes due to self-supporting structure. WDS® is able to withstand permanent temperatures of up to 1000°C (1832°F), it can also be incorporated into vacuum insulation with even lower thermal conductivity.

Braze alloys and solutions for fuel cell applications

Our Wesgo® branded high temperature braze alloys are also used in fuel cell applications, providing effective long term joining capability, and critical ceramic-to-metal bonding. Whilst our innovative Ultinex® brazing solution reduces five steps of ceramic brazing into one, streamlining the brazing process and opening up new multi-material joining capabilities.

Fuel cell testing

Morgan has been working with leading global names to develop and supply the ceramic housing and fixtures used as part of in-house SOFC testing. The ceramic housing must have a number of mechanical, chemical and electrical properties in order to withstand the harsh testing environment. Precise parts, to high tolerances, must also be able to be manufactured repeatedly. Our ceramics outperform materials such as Teflon and Al₂O₃/MgO spinell.

Key benefits

- Ability to operate at temperatures exceeding 1725°C (3137°F) for prolonged testing periods
- Highly electrically insulating
- Ability to achieve tight sealing
- Beneficial coefficient of thermal expansion resulting in reducing cracking
Non Renewable - Power generation and distribution

Traditional sources of energy generation continue to play a vital role in the modern energy mix, helping meet the increased demand for energy around the world.

World-class precision engineering capability combined with our materials portfolio offering superior physical, thermal and electrical properties, is enabling designers and manufacturers to meet new standards for the efficient delivery of power more efficiently. As a result we are increasingly being called on to develop components and sub-assemblies for new processes throughout the power sector.

In power distribution, Morgan provides precision-engineered materials, components and assemblies, enabling reliable and safe transmission of electricity in even the harshest environments. Whilst our broad range of dielectric materials includes high quality capacitance solutions for high voltage systems including our Live Line Indicators which help provide fault detection on power frequency high voltage distribution switchgear.

**Typical products**
- CERAMIC CORES
- FIRE PROTECTION BLANKETS, BOARDS
- HIGH VOLTAGE BUSHINGS
- HIGH VOLTAGE CAPACITORS
- INSULATING CASTABLES
- LIVE LINE INDICTORS
- CARBON BRUSHES AND HOLDERS
- INSULATING BLANKET
- SENSORS
- BRAZE ALLOYS

**Typical applications**
- STAND OFF INSULATORS
- CABLE INSULATORS
- FAULT DETECTION
- FUSES
- HIGH PRESSURE CABLE INTERCONNECTS
- GAS TURBINE PRODUCTION
- POWER DISTRIBUTION
- POWER SUPPLY (INSULATORS)
- POWER TRANSMISSION LINES
- SMART METERING
- POWER TRANSMISSION
- HEAT RECOVERY STEAM GENERATION

**Sensors for utilities measurement**
Morgan produces a range of sensor components and assemblies used in modern smart metering equipment providing accurate real time consumption data to energy users.
Industrial gas turbine components
Under our Certech® brand Morgan produces products including ceramic cores for the Industrial Gas Turbine (IGT) market. Our ceramics are used to create cooling passages within the blades and vanes of land based jet engines. The major benefit of our product is its stability it products manufacturers during the metal casting process.

Morgan also produces gas turbine engine swirls or swirlers used to blend and spin the air/fuel mixture as it is injected into the engine.

Braze alloys and solutions
Our specialist pre-sintered preforms are enabling the accurate dimensional restoration and repair of cracks in gas turbine components such as high pressure, gas turbine vanes, helping increase their service life by tens of thousands of hours.

Power distribution
High voltage bushings
Morgan’s high voltage (HV) brushings are available in variety of sizes and can be customised to meet specific specifications and needs enabling our HV bushings to be used throughout the power distribution process.

Key Features
- 95% ALUMINA
- HIGH TEMPERATURE GLAZE - RESULTING IN A HIGH SURFACE RESISTIVITY
- SOFT CAPS & FLANGES - 42% NICKEL-IRON WITH FUSED SILVER OR EQUIVALENT
- FINISH SUITABLE FOR SOFT SOLDERING
Heat Recovery Steam Generation

Heat Recovery Steam Generation (HRSG) plants play a major role in meeting the increasing demand for power. Our Thermal Ceramics business produces a range of highly engineered insulating fibre products that are ideally suited to offer the robust, long life and high performance demanded by HRSG applications.

Morgan's thermally insulating products are commonly used to help improve linings throughout HRSG systems. Whilst our Superwool® Plus™ blanket is used to help improve the linings of HRSG's, capable of surpassing the specifications of existing linings with a reduced amount of layers, resulting in improved efficiency throughout the systems. Morgan’s HRSG duct linings are accepted by all major OEM’s and specifiers and can withstand being compressed under stainless steel shrouds.
Typical Products and applications

1. STACKS
   SUPERWOOL® PLUS™ BLANKET,
   CERABLANKET®, KAOWOOL BLANKET
   AND PYRO-BLOC® MODULES

2. SILENCERS
   SUPERWOOL® PLUS™ AC2 BLANKET,
   CERABLANKET® AC AND CERABLANKET® AC2

3. DUCTWORK
   SUPERWOOL® PLUS™ BLANKET,
   CERABLANKET®, KAOWOOL BLANKET
   AND PYRO-BLOC®

4. AUXILIARY
   PYRO-BLOC® AND SUPERWOOL® PLUS™ BLANKET

5. FLOOR
   PYRO-BLOC® MODULES,
   INSULATING CASTABLES (KAOLITE®, FIRELITE®, TRIMOR®),
   INSULATING FIREBRICK (K®, JM™, TJM™),
   INSULATING BLOCK (TR®-19)

6. CASING HOTSPOTS
   THERMO-O-HOT PATCH™
   AND SUPERWOOL®
HRSG product highlights

Superwool® Plus™ Insulating Fibre
Is a high temperature low-biopersistent insulating material that provides excellent insulation in applications up to 1200°C (1093°F). This makes the product ideal for dealing with the demanding environment faced within HRSGs.

Benefits
• EXCELLENT THERMAL INSULATION PROPERTIES
• FREE OF BINDER OR LUBRICANT
• THERMAL STABILITY
• LOW THERMAL CONDUCTIVITY
• GOOD RESISTANCE TO TEARING AND VIBRATION
• EXCELLENT THERMAL SHOCK RESISTANCE
• LOW HEAT STORAGE CAPACITY
• INORGANIC - SMOKE FREE
• FLEXIBLE
• EXONERATED FROM CARCINOGENIC CLASSIFICATION UNDER NOTA Q OF EUROPEAN DIRECTIVE 97/69E

Pyro-Bloc® modules
Pyro-Bloc® modules comprise two sections of Superwool® fibre slabs in edge-grain orientation, held in position with two stainless steel tubes. This, and their high density makes them much more resistant to erosion than folded modules, particularly where a high velocity of gas moving through the unit tends to abuse linings. Pyro-Bloc® monolithics fibre is easy to cut and fit around openings and modify in the field. It provides a superior finished surface for such special shapes as peep site frames, tube penetrations and burner tiles. The modules are especially ideal for corners, bullnoses or transition sections.

Benefits
• HIGH UN-COMPRESSED DENSITIES GIVE LOW THERMAL CONDUCTIVITY AND A MORE UNIFORM AND FASTER INSTALLATION
• FAST ONE STEP INSTALLATION
• ALL WELDS AUTOMATICALLY TORQUE TESTED
• RESISTANT TO MECHANICAL DAMAGE AND GAS FLOW ABRASION
• LUBRICATED FIBRE ALLOWS MORE UNIFORM COMPRESSION AND TIGHT JOINTS
• EXONERATED FROM ANY CARCINOGENIC CLASSIFICATION UNDER NOTA Q OF EUROPEAN DIRECTIVE 97/69E
• ANCHORAGE REMOTE FROM THE HOT FACE PROTECTS STEEL WORK
High voltage capacitors

Morgan has decades of experience manufacturing high voltage ceramic capacitors including those for both DC and power frequency (50/60Hz) applications. Our products are used worldwide in challenging service conditions and are backed by rigorous testing procedures to ensure their electrical integrity and long service life.

**Live-line capacitors**

Our live-line capacitor assemblies are built into capacitor divider circuits and connected to medium high voltage lines and used to sense the presence of voltage on the lines.

Key Features:
- 24-36kV system voltage options available
- Wide range of capacitance values and metalwork fitting styles available

**Voltage multiplier assemblies**

Our series connected disc capacitors have been developed for use in low power voltage multipliers for high voltage DC generators. They are typically used in the manufacture of voltage multipliers for electrostatic paint spraying equipment as their compact form make them ideally suited for incorporation in hand held electrostatic spray guns.

**Pulse power capacitors**

This high voltage resin encapsulated disc capacitor range features a new strontium based, low-loss, high permittivity dielectric. It has been specifically designed to function in circuits with high peak current and high repetition rates.

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Electrical Carbon products

Whether driven by gas, coal, oil, wind, water or nuclear energy, our National 634 carbon brushes are the preferred choice used by a number of OEMs manufacturing power generation equipment. The National 634 grade is recognised globally as the best performance material in power generation being the "gold standard" for turbo alternator applications.

We also produce a range of other products including; carbon brushes, holders, slip rings, terminal blocks and Aegis SGR™ rings are used for turbo generators and bearing protection.

**Key benefits**

- RELIABLE AND CONSISTENT PERFORMANCE
- PROVEN LONG LIFE CAPABILITY
- LOW WEAR OF BOTH BRUSH AND SLIP RING SURFACE
- EXCELLENT CURRENT SHARING CAPABILITIES
- LOW AND STABLE FRICTION
- CONSISTENT CONTACT DROP
- AVAILABLE TO FIT ANY GENERATOR
MORGAN ADVANCED MATERIALS

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