Morgan
Advanced Materials

Advanced Solutions for Automotive Applications

THERMAL CERAMICS

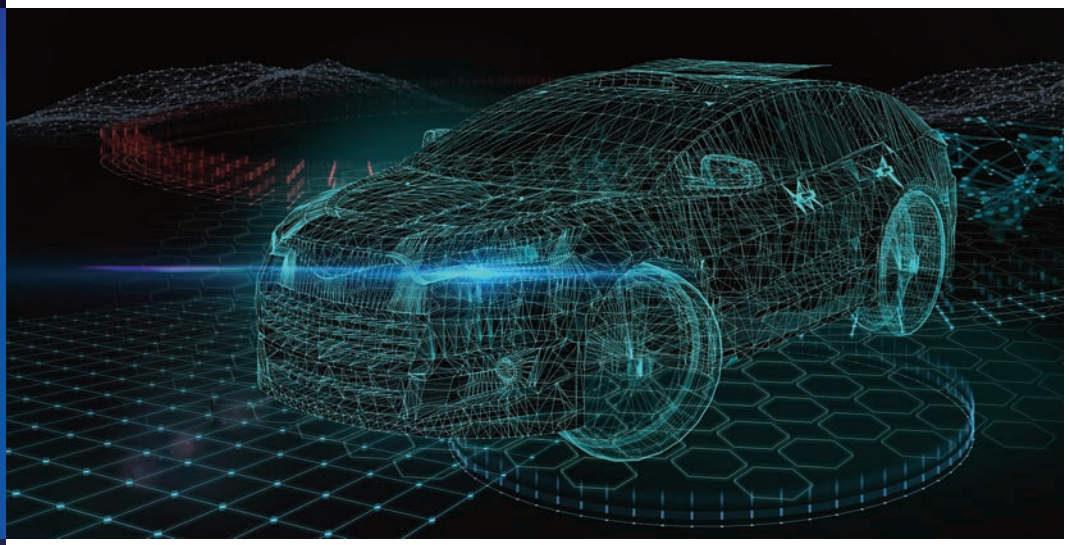
Morgan Advanced Materials

Thermal Ceramics
Innovative solutions for automotive applications

Contents

Thermal Ceramics manufactures a wide range of materials and components used throughout the global automotive market.

From thermally insulating heat shields and exhaust after treatment components to advanced fibre technology for Electric Vehicle lithium ion battery systems, we are at the forefront of technology helping manufacturers improve vehicle safety, performance, energy efficiency and comfort to create more fuel efficient, safer vehicles.



Harnessing our world-class design expertise and specialist manufacturing capabilities, we work in partnership with some of the world's largest tier-one and tier-two automotive suppliers by developing competitive tailored solutions to meet the increasingly challenging and changing demands of the automotive market.

Typical products

- WDS® MICROPOROUS INSULATION
- SUPERWOOL® INSULATING FIBRES
- HEAT SHIELDS
- SUPERWOOL® and KAOWOOL® PAPER

Our expertise has also been called upon by high performance race car developers and even used in world land speed record attempts.

Morgan's insulating products are also used in railway applications as well as many other road vehicles including heavy goods vehicles, buses, motorcycles and scooters.

Engineered fibres significantly increase brake friction pad stability over a wide temperature range and improve fade and recovery characteristics - without increasing rotor wear or pad weight loss; providing noise reduction.

Helping drive development and innovation in the global automotive market

Heat Shields

Morgan's thermal acoustic heat shields are multi-layered products designed to provide optimum performance in high temperature environments. The main function is to maintain heat inside the system while protecting surrounding areas where space is a premium. Combining our expertise in advanced fibre technology, Morgan products provide a safe, reliable and cost effective solution for our customers.

Our Global Advantages

- Vertically integrated within the supply chain to provide materials from manufacture of our own proprietary fibre, supplying die cut parts through to a complete heat shield
- Engineered with the automotive industry leaders to ensure demanding challenges achieved
- Global manufacturing, engineering and customer services

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Integrated Technology

Our products are engineered to customer specifications. From design to the final assembly and installation, we offer several types of automotive heat shields designed for the specific application type and thermal need.

Shell Technology Heat Shield is a durable, lightweight insulation designed to fit directly on to a part. The automotive heat shields are available in a variety of steels from 0.05 mm thickness, corrugation surfaces for maximum strength, combined with single or multi-layer insulation from our Superwool®, Glass or Silica Fibre offering a high thermal performance solution.

Sandwich Technology Heat Shield is engineered to protect the application against moisture intrusion or salt water corrosion. The design of the heat shield is easy to assemble, features high temperature performance up to 1050°C (1922°F) using our WDS® Microporous thermal insulation. The Sandwich Technology Heat Shield has a minimum thickness <5 mm.

Key advantages to our automotive heat shields are:

- Lightweight and space critical engineered solutions
- Superior thermal and acoustical performance
- Safety Edges - all automotive heat shields are designed with a safe edge feature
- Complete assembly development - automotive heat shields from Morgan are engineered, designed, developed and delivered to the customer's site for installation or completely assembled to the application
- Quick change tooling, durable crimping and / or welding assembly are all critical in automotive heat shield manufacture and delivery

Passive Fire Protection Capabilities

Flexible and rigid technologies dedicated to maintain low temperature on valves, actuators / pipes in case of fire.

- Continuous development for Jet Fire and Hydrocarbon fire 60 minutes following UL 1709 and ISO 22 899-1
- Specific fire protection insulation are designed for each project upon the time / temperature requirements, site conditions, thermal mass of the materials being protected, air flow and a number of other variables

Friction

Manufacturing engineered fibres that increase brake pad performance stability over a wide temperature range - without increasing rotor wear or, excessive pad weight loss, or causing NVH issues.

Our full chemistry and temperature range of engineered low biopersistent fibres Superwool® Enfil™, are made from pure raw materials; without unwanted trace minerals.

- **Exonerated from carcinogen classification throughout the world**
- **Manufacturing globally to support automotive manufacturing in every region**

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Today's largest global brake pad manufacturers utilise low biopersistent Superwool Enfil fibre options in OE and aftermarket formulations.

- **Fibre length options for reinforcement and filler functionality**
- **Fibre chemistry options with thermal stability in excess of 1200°C (2192°F)**
- **Fibre index options to meet or exceed application performance requirements**

Friction
Superwool Enfil fibres are a key performance enhancing component of OE and aftermarket friction products throughout the world for many years.

Commitment to research and development

Our comprehensive commitment to research and development and strong partnerships with the automotive market ensures that our products remain at the technical edge and continue to push boundaries.

- **Patented technology**
- **Global sourcing**
- **Environmentally responsible**

Electric Vehicles

At Morgan, we engineer, manufacture and supply technologically advanced fibre and microporous materials to help the automotive industry solve complex thermal runaway and fire protection challenges in electric vehicles.

Morgan manufactures a range of Superwool® EST (Energy Storage Technology) and WDS® Microporous products designed to prevent the propagation of thermal runaway in electric vehicle and energy storage applications. We collaborate with our customers to integrate EST products for thermal runaway protection in cell-cell, module-module, and pack protection systems. Concerns for space and weight can be mitigated with EST materials including:

- Solid shapes
- Paper
- Bulk powder

Morgan's global manufacturing footprint allows us to work directly with your team whether they are in Asia, Europe, or the Americas. Our many years of manufacturing and direct supply to the automotive industry give us the background needed to bring ideas and material solutions into the reality of volume production.

Application Engineering

Extensive range of high temperature insulation products used to thermally manage battery and fuel cell systems.

- **Working with customers to understand application and define performance parameters**
- **Research to find the best material for your system**
- **Development of prototypes and pilot production**

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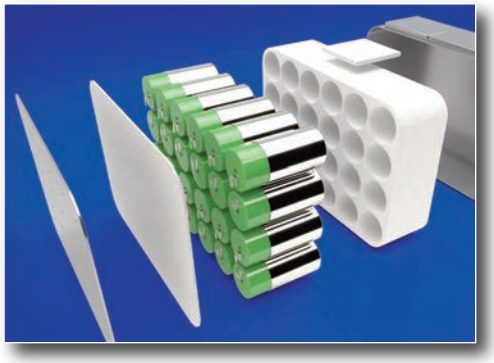
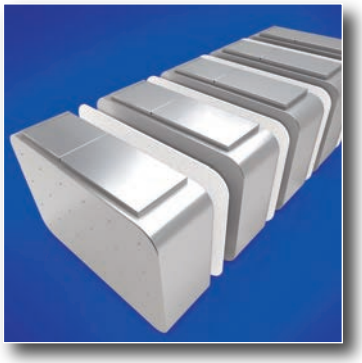
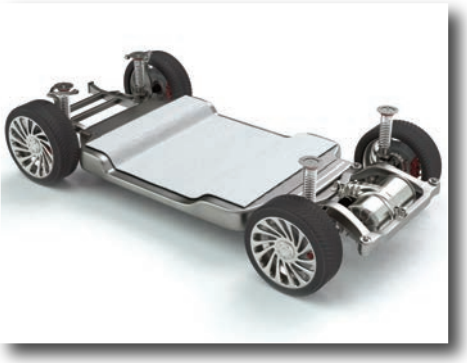
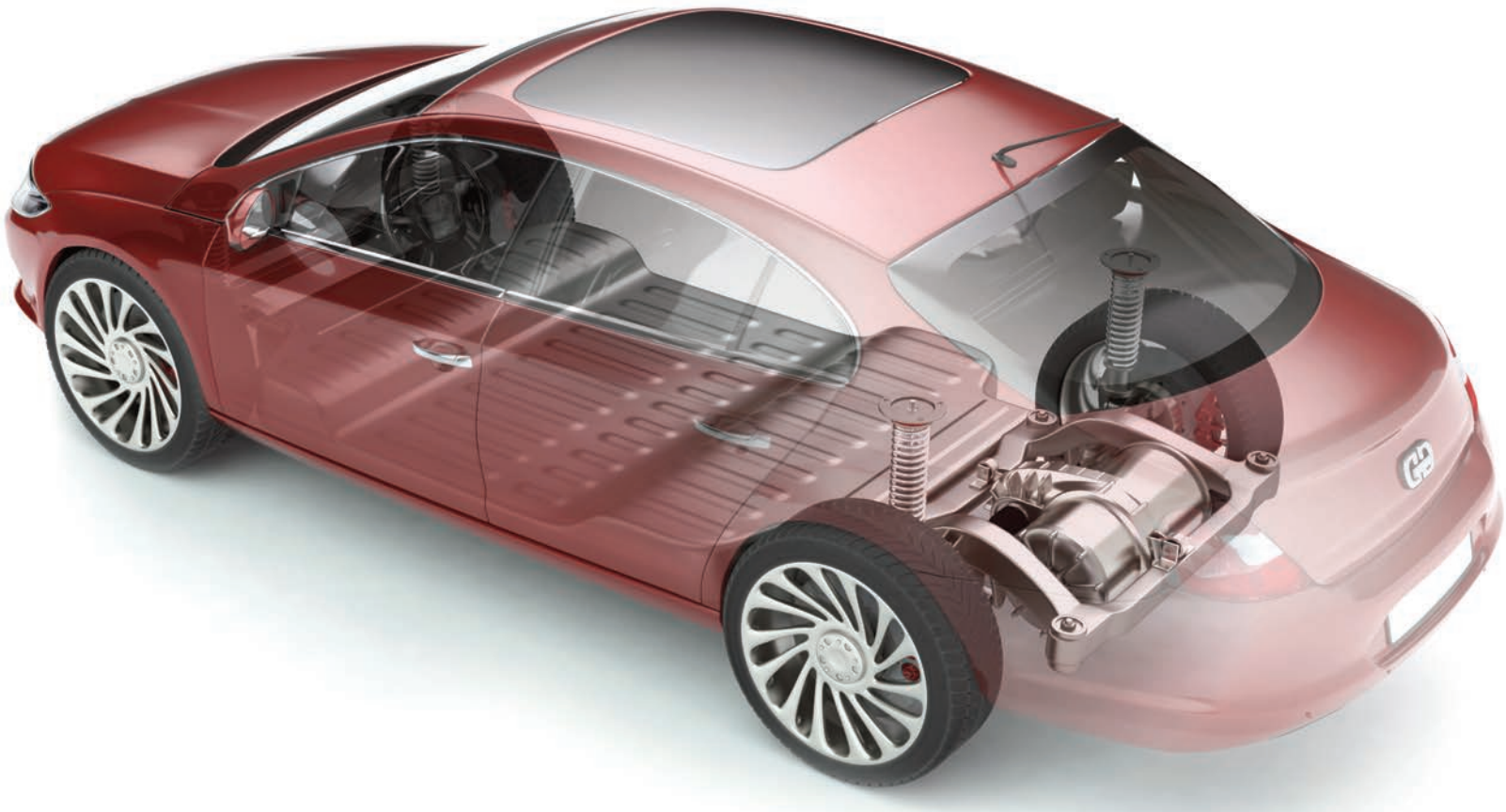
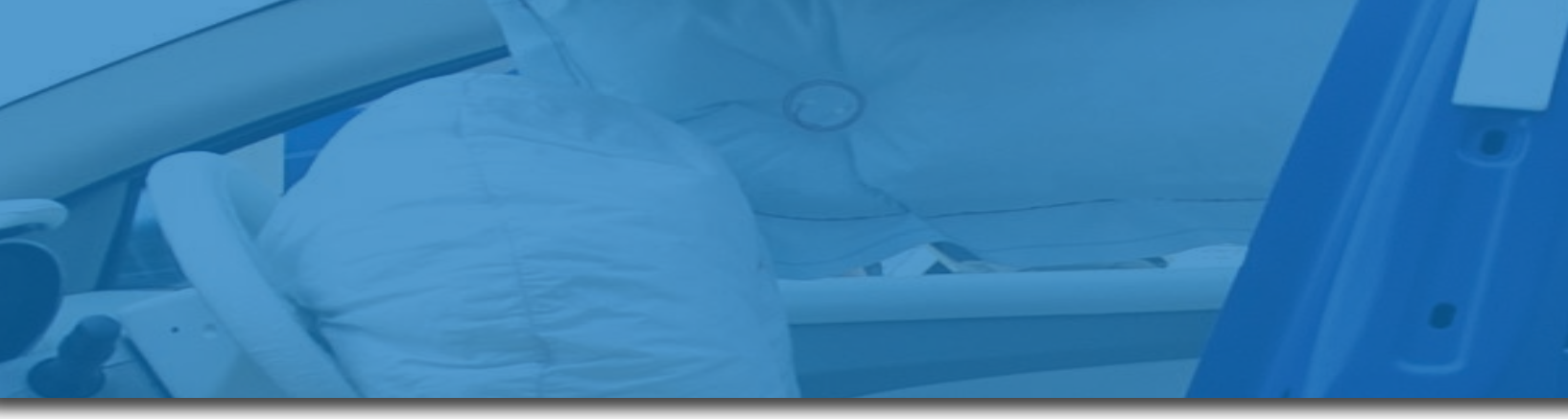








Manufacturing cutting edge materials to help our customers solve complex thermal runaway and fire protection challenges in electric vehicles



Filtration and Emissions Control

Manufacturer and supplier of engineered fibres to market leading catalyst and DPF manufacturers.

Manufacturer and supplier of high temperature, thermal insulating performance fibres specifically engineered to meet airbag inflator performance requirements.

- Filter out particulates that could damage the airbag and burn the occupants
- Cool the hot gases emitted when the airbag goes off
- Provides cushion and deadens sound in the propellant compartment

Our low biopersistent Superwool® fibres and WDS® Microporous materials are manufactured to meet the application demands of the automotive OE and after market industry for emissions controls.

A global manufacturing capability, supplying regional demands

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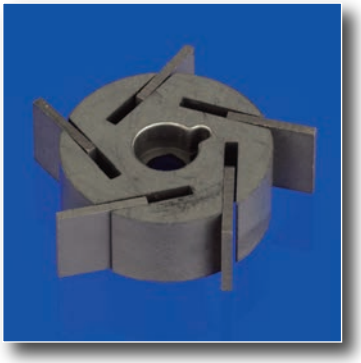
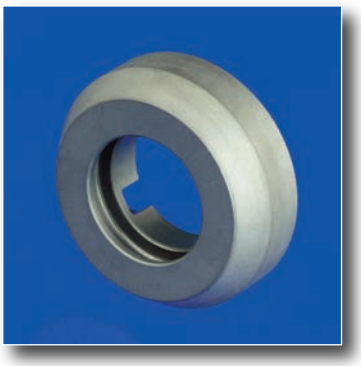
Morgan's Automotive Business

Morgan provides the global automotive sector with a wide range of components that are used in modern cars and to aid vehicle manufacturing.





Harnessing our world-class design expertise and specialist manufacturing capabilities, we work in partnership with some of the world's largest tier-one automotive suppliers, developing competitive tailored solutions to meet the increasingly challenging demands of the sector. We are the forefront of technology helping manufacturers improve vehicle safety, performance, energy efficiency and comfort to create more fuel efficient, safer vehicles.

Products used in vehicles

Morgan's ultrasonic sensors are used in personnel detection systems, enabling automotive manufactures to ensure that the airbags are deployed in the safest possible manner according to the passenger's position and meet stringent safety requirements.

Hybrid vehicle cooling pumps

The properties of our ceramic materials is enabling the pump technology needed in electric and hybrid vehicles to circulate aggressive coolant through the Lithium-ion batteries, whilst also providing weight saving benefits.

Carbon / bearings vanes and rotors

Our Seals and Bearings business also produces carbon / graphite vanes and rotors offer outstanding thermal and chemical resistance properties along with superb wear resistance. Applications include; Fuel Pumps, Water Pumps (Cooling / Heating), EGR Valves and Electric Vacuum Pumps.

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

We focus 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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