

Morgan Advanced Materials  
insulation solutions for

# Fuel Cells & Electrolysers

created using **advanced materials**  
to make the world more **sustainable**  
and to **improve** the **quality of life**

# Fuel Cells

At Morgan, we have history of innovating and driving new technologies to make the world more sustainable. Our ultra-thin, lightweight and adaptable insulation solutions for SOFC, SOEC, MCFC and PEMFC offer best in class performance, weight savings, safety and can help significantly reduce total cost of ownership.

Benefitting from a global manufacturing footprint, Morgan is an industry leader in developing insulation solutions for residential, commercial, industrial, marine, data centres fuel cells.

Partnering with Morgan from the initial stages of the fuel cell design will give you access to our:

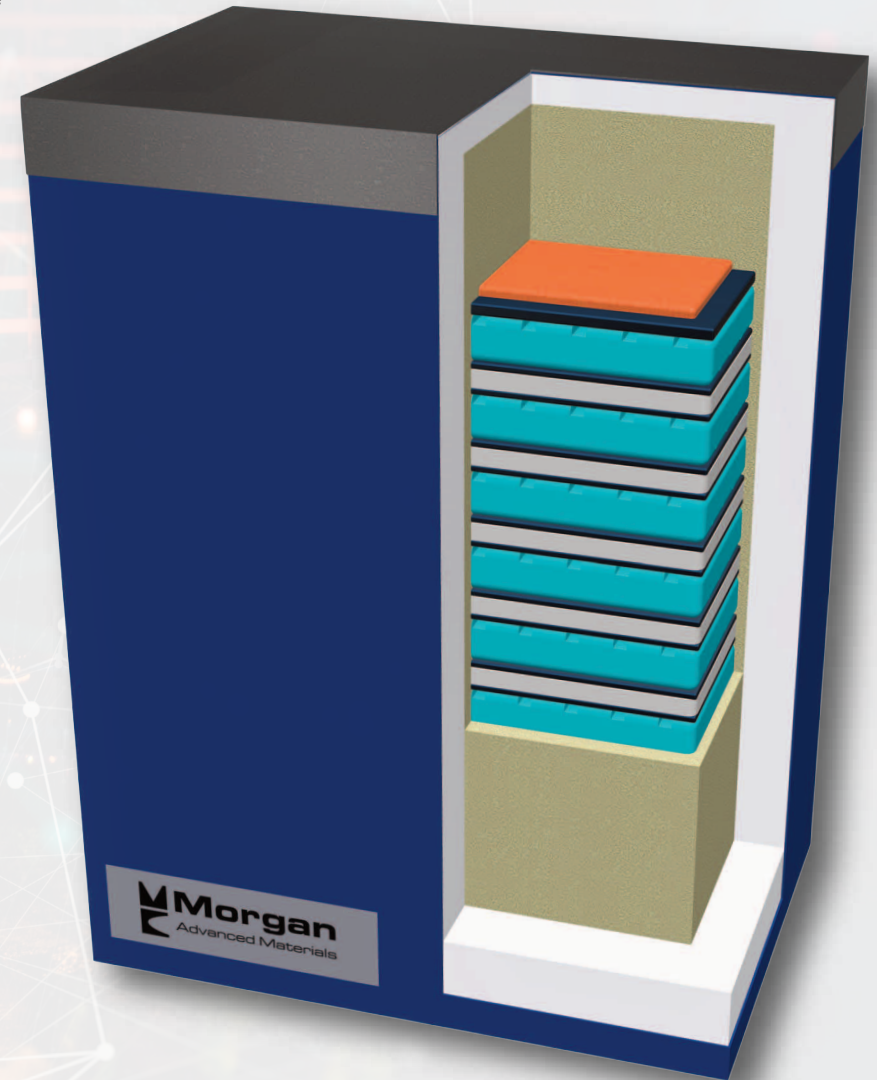
- In house design and testing, prototyping and production manufacturing capabilities
- Ability to combine our extensive range of materials in dedicated solutions to match your unique requirements
- Consolidated knowledge and consulting for high-temperature heat management systems design

At Morgan, we are committed to a sustainable future.

Our aim is to ensure that our products and manufacturing processes are designed, built and managed in a way that enhances their value to society and our environment. We are also proud that through their life, our products typically save tens or hundreds of times the CO<sub>2</sub> emitted during manufacture, allowing our customers to lessen the impact of climate change.

## Contents

An introduction to Morgan Advanced Materials	3
Product solutions	4
Fuel Cell - applications of Morgan products	6
SOFC, SOEC, MCFC fuel cells product range	8
Partnering with us	10
Sustainability and responsibility	11





# Morgan Advanced Materials

We innovate to meet the challenges of a changing world



## Safe and Reliable Products

Our products and systems protect lives and processes 24 hours a day and 365 days of each year.



## A Truly Global Footprint

We have operations on 5 Continents and in 30 Countries to efficiently serve our Customers.



## Commitment to Innovation

For you, for us, for our people and our planet our commitment to innovation is paramount in all we do.



## Trusted Engineering Services

Our global resources and dynamic engineering services efficiently support our Customers application demands.

Morgan Advanced Materials makes advanced ceramic products and systems for thermal insulation in high temperature environments. We engineer products and systems for equipment in demanding applications and for the safety of people.

Our solutions help customers, especially those operating energy intensive processes, to reduce energy consumption, emissions and operating costs.

## What we do in the Fuel Cell sector

Our thermal insulation solutions for stationery and transport fuel cells provide materials that minimise heat loss, improve operation efficiency and ensure optimal considerations for weight and space.

Our ultra lightweight, thin and flexible WDS<sup>®</sup> Microporous portfolio are ideal solutions where complex design configurations and space are required.

In addition to our WDS Microporous, our fibre based high temperature, high performance Superwool<sup>®</sup> and EST<sup>™</sup> and Pipe Insulation materials provide thermal management to high temperature fuel cells - SOFC, SOEC and MCFC.

We offer dedicated engineering services at every stage of your project from design specification to material selection to deliver complete insulation systems.

Harnessing our world-class design expertise and specialist manufacturing capabilities, we work in partnership to develop competitive tailored solutions to meet the increasingly challenging and changing demands of the fuel cell market.

[www.morganthermalceramics.com](http://www.morganthermalceramics.com)

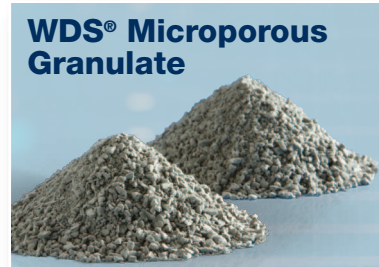
[#wearemorgan](https://twitter.com/wearemorgan)

# Product solutions

Our wide range of low thermal conductivity, lightweight and adaptable insulation solutions enable maximum utilisation of available space, allow for a more compact design of your application and drastically reduce installation times.

**Our most commonly used solutions are:**

- WDS® Microporous Granulate
- WDS® Ultra
- WDS® Nextra®
- WDS® LambdaFlex® Super
- WDS® Flexipor®
- Superwool® Prime
- Superwool® Boards and Shapes
- Kaowool® Papers



**WDS® Microporous Granulate**

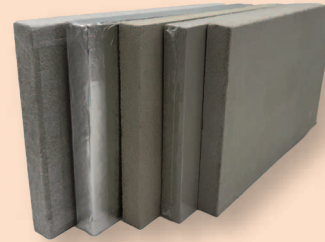
WDS Granulate is an inorganic loose-fill pourable granular microporous insulation with very good insulation properties and excellent resistance to heat.

It features very low thermal conductivity whilst maintaining a very low density, even after compaction. WDS Granulate can be easily poured and homogeneously distributed through vibration from the outer casing of any closed system in which WDS Granulate is contained, and it is therefore the ideal solution for filling space and voids of complex geometries having limited space structures and where shaped and rigid insulation cannot be applied or would require less cost-effective complex machined components to be considered.

**Benefits:**

- Extremely favourable kg cost / volume ratio
- Simple and efficient installation
- Allows to design safer and lighter structures
- Helps to control energy efficiency and heat flow very precisely
- Cost efficient insulation for complex geometries

**WDS® Ultra Board**



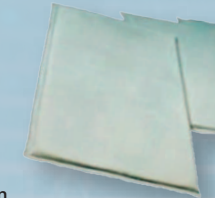
WDS Ultra Board is a rigid microporous insulation board designed for applications up to 1000°C (1832°F) where excellent handling characteristics and a high compressive strength to density ratio are the main selection criteria.

All WDS microporous insulation solutions offer exceedingly low thermal conductivity at high temperatures by limiting convection, conduction and radiation with the most effective methods possible. This results in an insulating solution that is several times better than typical high temperature lightweight insulation materials. WDS microporous insulation solutions are the ideal choice for increased energy savings, space optimisation and/or reduction of weight.

**Benefits:**

- Light weight and low heat capacity while retaining high strength
- Design flexibility whether you need to save energy or create space
- Suitable for applications requiring rapid heat up or cool down
- Dimensionally and structurally stable up to the maximum classification temperature
- Suitable for curved surfaces and pipes

**WDS® Nextra® Panel**



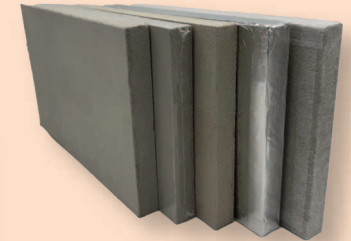
WDS Nextra Panel is a rigid compact microporous insulation constituted of a mineral core enveloped in a non-combustible cloth being typically E Glass.

Its engineered mineral matrix is designed for applications where the lowest thermal conductivity up to 1000°C (1832°F) is the main selection criteria. Like any other microporous insulation of our industrial range produced with our exclusive WDS Technology process, it features extremely good handling properties, low thermal conductivity coefficient giving it very good insulating properties in limited thickness allowing to design equipment where high energy efficiency, space optimisation and reduction of weight are premium factors to be considered.

**Benefits:**

- Dimensionally stable over time up to the maximum using temperature
- Helps to control energy efficiency and heat flow very precisely
- Easy to cut and with proven installation techniques
- Freedom in engineering at the design stage
- Increases effective volume inner capacity or reduces encumbrance in equipment and apparels of any kind

**WDS® Nextra® Board**



WDS Nextra Board is a rigid and compact microporous insulation board designed for applications where the best thermal insulation performance (lowest thermal conductivity) up to 1000°C (1832°F) is the main selection criteria.

All WDS microporous insulation solutions offer exceedingly low thermal conductivity at high temperatures by limiting convection, conduction and radiation through advanced techniques. This results in an insulating solution that is several times better than typical high temperature lightweight insulation materials. WDS microporous insulation solutions are the ideal choice for increased energy savings, space optimisation and/or reduction of weight.

**Benefits:**

- The use of the most thermally efficient WDS Board allows for the ultimate design flexibility whether you need to save energy or create space
- Suitable for applications requiring rapid heat up or cool down
- Very good handling and machining capabilities
- Suitable for a variety of applications
- Environmentally friendly and safe

## WDS® LambdaFlex® Super

WDS LambdaFlex Super is an encapsulated flexible and compact microporous insulation sheet specifically designed for applications requiring resistance to compression, together with low shrinkage and very low thermal conductivity up to their classification temperature.



Flexibility and water repellence are ensured by an outer encapsulation facing, constituted of a PE/Aluminum foil envelope which protects the microporous core. This product features extremely good handling and cutting properties, low thermal conductivity coefficient giving it very good insulating properties in limited thickness allowing to design equipment where high energy efficiency and energy storage, space optimisation and reduction of weight are premium factors to be considered.

### Benefits:

- Dimensionally stable over time up to the maximum using temperature
- Helps to control energy efficiency and heat flow very precisely
- Easy to cut and with proven installation techniques
- Adapts well on curved surfaces
- Increases effective volume inner capacity

## WDS® Flexipor®



WDS Flexipor is a light weight microporous flexible insulation designed for applications where high compressive strength, flexibility associated to low thermal conductivity are the main selection criteria. WDS Flexipor is a sheet constituted of a microporous insulation compact core covered with a low biopersistence fibre paper on both sides which is then encapsulated in a PE foil to provide high flexibility of the finished product.

It features extremely good handling properties, low thermal conductivity coefficient giving very good insulating properties in limited thickness, allowing the design of equipment where high energy efficiency, space optimisation and reduction of weight are premium factors.

### Benefits:

- Dimensionally stable over time up to the maximum using temperature
- Helps to control energy efficiency and heat flow very precisely
- Easy to cut and with proven installation techniques
- Increases effective volume inner capacity or reduces encumbrance in equipment and apparels of any kind

## Superwool® Prime Paper



Superwool Prime Paper is manufactured using Morgan's newest fibre chemistry with a classification temperature of 1300°C (2372°F). Using patented low-shot technology fibres in a non-woven matrix with special organic binders, it has high strength for various applications.

These papers have excellent non-wetting characteristics for applications requiring direct contact with molten aluminium.

Superwool provides stability and resistance to chemical attacks. Exceptions include hydrofluoric acid, phosphoric acid and strong alkalis (i.e. NaOH, KOH). In addition, Superwool is unaffected by incidental spills of oil or water. Thermal and physical properties are restored after drying.

### Benefits:

- Low biopersistence fibre
- Excellent thermal insulating performance
- Thin, flexible high temperature insulation
- Immune to thermal shock
- Low heat storage
- Easily die-cut to form complex shapes for high-temperature gasketing
- Excellent tensile strength

## Superwool® Boards and Shapes

Superwool inorganic boards and shapes are processed from a slurry consisting of Superwool bulk fibre and inorganic binders. Boards up to 36" wide may be ordered with both surfaces machined smooth to a close thickness tolerance.



Superwool is a low bio-persistent fibre, manufactured from pure raw materials and processed to offer excellent performance in high-temperature applications. It offers an alternative to traditional solutions due to its high refractoriness and excellent non-wetting characteristics with molten aluminium.

Superwool is ideally suited to individual applications and is available in a wide range of thicknesses and densities. The maximum continuous use temperature depends on the application.

### Benefits:

- Rigid, self-supporting fibre insulation
- Available in a variety of sizes and thicknesses
- Based on patented technology
- Reduces thickness of backup insulation up to 50% when replacing insulating firebrick or castables
- Low thermal conductivity and heat storage
- Non-wetting to molten aluminium

## Kaowool® Papers



Kaowool Papers are manufactured from high-purity refractory fibres and designed for high-temperature insulation. Advanced production techniques ensure uniform fibre distribution and close control of thickness and density.

Kaowool Papers are produced from alumina-silicate fibres with the minimum addition of carefully selected bonds, which burn out cleanly in service.

Kaowool Papers exhibit excellent strength, flexibility and good handling characteristics. Other beneficial properties include low thermal conductivity, low thermal mass and exceptionally high thermal shock resistance.

### Benefits:

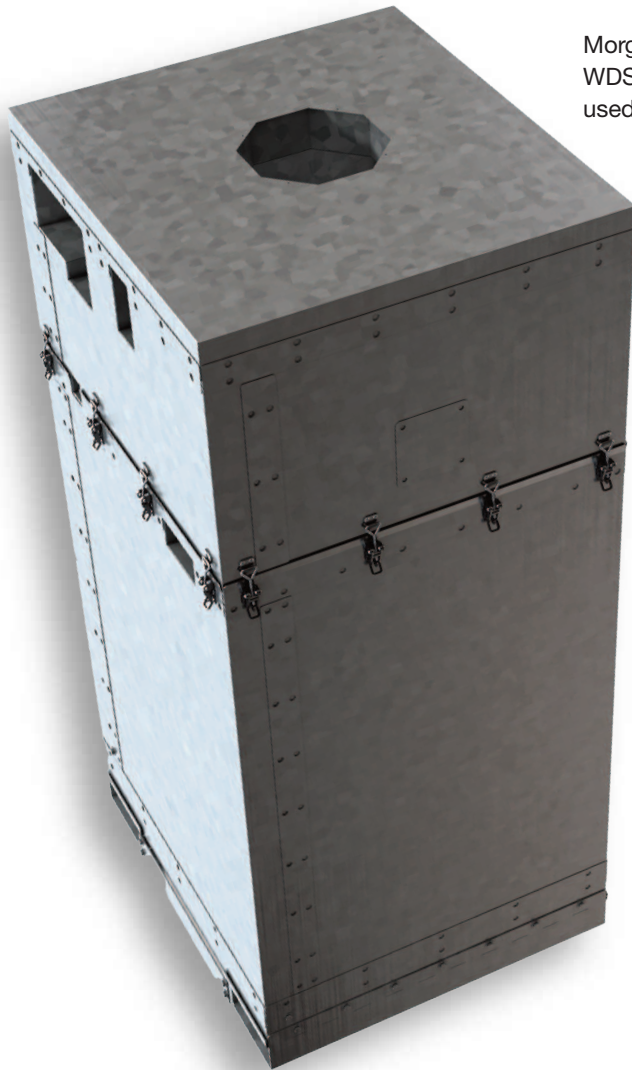
- Good resistance to tearing
- High flexibility
- Low shot content
- Precise thickness
- Resistant to thermal shock
- Very low thermal conductivity
- Thermal barriers for vehicles (silencers, catalytic exhausts and heat shields)
- Fire protection



# Fuel Cell applications of Morgan products

## Hot box insulation and design

The high temperature operational requirement of SOFC, SOEC and MCFC fuel cell (600°C – 900°C) can be effectively solved with the Morgan WDS® product range.



Morgan WDS Microporous Granulate and WDS Ultra® and Nextra® boards are primarily used for this part of the cell, effectively reducing external shell temperature to as low as 50°C, maximising heat loss and optimising stack performance.

In addition to class leading insulation solutions, Morgan's engineering and manufacturing capabilities provide full design, testing and prototype manufacturing solutions with regards to the design and heat loss simulation analysis of the hot box.

## Balance of plant

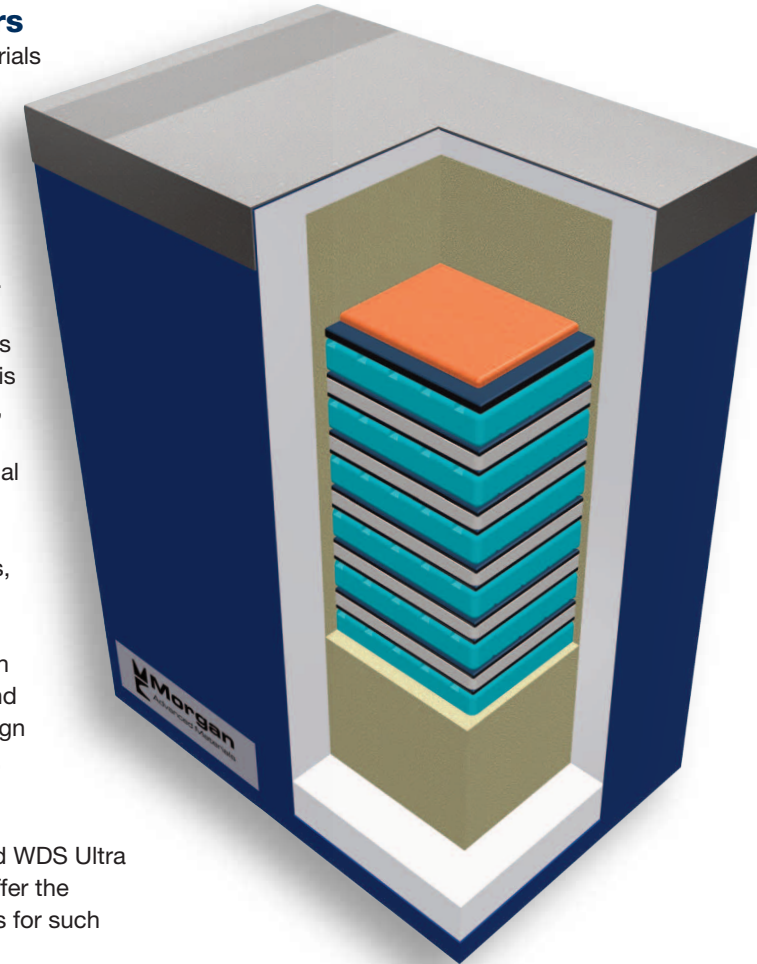
WDS Microporous, our fibre based high temperature, high performance Superwool® and EST™ and Pipe Insulation materials provide thermal management to high temperature fuel cells.

## Reformers

Morgan materials address the unique challenges posed by small residential PEMFC units.

In applications where space is at a premium, the use of conventional insulation materials is, in most cases, not feasible.

To tackle such challenges and complex design requirements, Morgan WDS Microporous Granulate and WDS Ultra and Nextra offer the right solutions for such applications.



## Fully integrated approach

Morgan offers a fully integrated approach, from consulting and bespoke solution design to product manufacturing and pre-assembly. Our extensive experience spans a wide range of industries and market sectors dealing with high-temperature applications.

Our mission is to satisfy customer using our team of technical specialists to support with:

- Consolidated knowledge and consulting for high-temperature heat management systems design
- Expertise in different markets and application
- In house design and testing capabilities
- In house prototype and production manufacturing capabilities
- Ability to combine our material in dedicated solutions to match our Customer's expectation

By leveraging the lowest thermal conductivity of their super-insulating materials and combining them in a dedicated selection of products, Morgan can meet stringent requirements for energy savings, prioritising quality and safety in operating conditions.



## Logistics solutions

Full support in designing the most cost effective and safe logistics solution for each application - from transportation to storage and production line use:

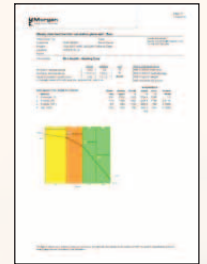
- Flexible packaging
- Custom packaging
- Silo transportation
- On-site storage
- Flowability analysis
- Densification analysis
- Grain size distribution analysis
- Bulk density analysis



## Your development partner for every step of your project

### Thermal simulations

Dedicated software to evaluate thermal heat losses and estimate steel shell temperature in standard operating conditions.

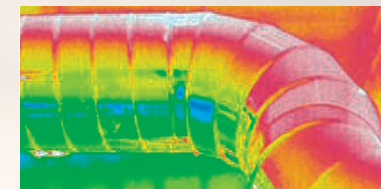


### Design and technical support

Technical support for the design of high temperature management systems.

### On-field assistance

Supervision services with specialised and certified personnel; installation activities together with reliable partners.

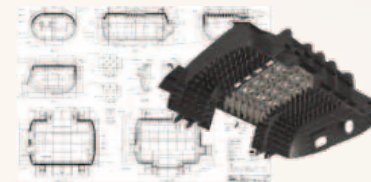


### Thermal analysis

Thermography inspection with infrared camera to evaluate and assess thermal performances of high temperature energy systems under operating conditions.

### Material selection

Proper selection of products and its combination to meet Customers' needs and expectations.



### 3D-2D estimation and design

Ability to perform 3D as well as 2D executive engineering to minimise risk of interferences during system solution assembly.



# SOFC, SOEC, MCFC fuel cells product range

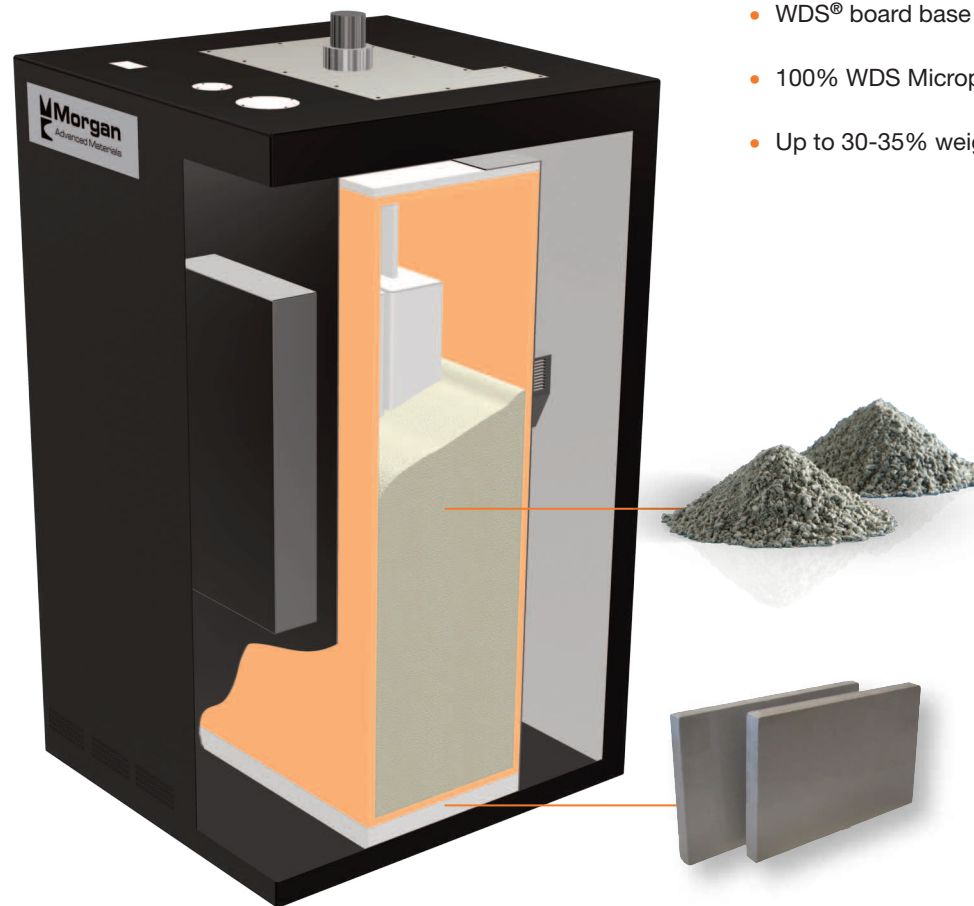
Partnering with Morgan will help drive your growth, especially when you work with Morgan from the beginning of your design.

Our solutions, experience and technical expertise can assist you in developing a solution that is scalable, ensuring you can continue to expand as the world moves towards a sustainable future.

## Customer request

Material integration in customer design

- WDS® board base insulation
- 100% WDS Microporous Granulate
- Up to 30-35% weight saving vs. competition



**Microporous**  
insulating  
products **WITH WDS**  
TECHNOLOGY

**Superwool® Plus™**  
Insulating fibre



## Prototype development

### Problem solving

- Engineering Design Services
  - 3D CAD modelling
  - Thermal modelling heat loss
- Superwool® 3D formed shapes for exhaust insulation
- Reduce void risks with Superwool blankets



## Optimised insulation system

### Turnkey solution

- Thermal bridges / safety risks mitigated
- Replace 30% WDS Microporous Granulate with lower cost blanket insulation reducing TCO
  - 5% additional weight saving
  - 10-15% cost savings
- Integrated Logistic System for low to high volume supply



## Partnering with us

We are the partner of choice for the fuel cell sector. Working with us, customers are able to push the boundaries of performance without compromising safety, heat or weight management.

Our custom solutions are developed using our patented Superwool® and EST™ and Pipe Insulation Fibre and WDS® Microporous materials.

These technologies help designers achieve optimal thermal management and passive fire protection, throughout petrochemical and refinery installations.



Morgan offers products and engineered systems for high-performance fire protection applications in a wide variety of industries world-wide

### Benefits of partnering with Morgan

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

- **Research and development**

A dedicated team focused on innovating within the petrochemical industry, developing superior materials which excel in real-world applications.

- **Global manufacturing**

Operations on five continents, where we collaborate with customers and deliver solutions in region to support the 'just in time' manufacturing model.

- **Supporting the reduction of carbon dioxide**

Innovative solutions, designed and engineered to drive a reduction in emissions.





# Together, we are working to reduce our environmental impact...

...together, we are working to deliver robust environmental, social & governance (ESG) practices, and together, we have defined **five** environmental, social, and governance (ESG) improvement objectives and targets to improve our performance as a Group:

## Reduce our environmental impact



- 1 Our aspiration is to be a CO<sub>2</sub> net zero business by 2050. Our 2030 target is to reduce our scope 1 and scope 2 CO<sub>2</sub> emissions by 50% (from a 2015 baseline). We will start to measure scope 3 emissions from 2023 onwards, with coverage increasing over time.
- 2 Our aspiration is to use water sustainably across our business. Our 2030 target is to reduce our overall water usage by 30% and reduce our water usage in high stress areas by 30% (from a 2015 baseline).



## Improve our safety performance

- 3 Our aspiration is to create an environment and culture with zero harm to our employees. Our 2030 target is a lost time accident rate below 0.1 (lost time accidents per 100,000 hours worked).



## Improve the diversity and inclusion of our business

- 4 Our aspiration is that our employee demographics reflect the communities that we operate in. Our 2030 target is for 40% female representation across our leadership population of our organisation.
- 5 Our aspiration is a welcoming and inclusive environment where our employees can grow and thrive. Our 2030 target is to attain a top quartile employee engagement score.

For more information please visit:

[www.morganthermalceramics.com/sustainability-responsibility](http://www.morganthermalceramics.com/sustainability-responsibility)

#wearemorgan



2024 bronze  
EcoVadis medal winner



Morgan holds an MSCI ESG  
Rating of AAA



2.7k trees

We're committed to offsetting  
our digital carbon footprint

## Morgan Advanced Materials

Significant trends shape our modern world, accelerating the demand for new and more sustainable advanced materials.

At Morgan Advanced Materials, we use advanced carbon and ceramics materials to support the move to a more sustainable world. Our people are driven to solve complex customer problems: from managing heat and enabling greener technologies, to supporting improved medical diagnostics and protecting life.

Our purpose is 'to use advanced materials to make the world more sustainable, and to improve the quality of life'. This purpose is underpinned by our safe, ethical and inclusive culture, embraced by our 7,800 employees spanning over 25 countries. Working across many industries and in a number of markets, we deliver the materials science and technologies the world needs now.

### Our Strategy

We are a global advanced manufacturing organisation with leading capabilities in three areas: materials science, application engineering and customer focus.

### Our Business Model

We operate as two global divisions and five global business units. We empower our global business unit teams, giving them considerable autonomy and enabling them to act quickly and support their customer needs. Our broad manufacturing footprint enables us to supply customers locally from a short supply chain.

[www.morganthermalceramics.com](http://www.morganthermalceramics.com)  
[www.morganadvancedmaterials.com](http://www.morganadvancedmaterials.com)

Morgan Advanced Materials plc  
York House, Sheet Street,  
Windsor, Berkshire, SL4 1DD. United Kingdom.

For all enquiries, please contact our specialist sales and marketing offices:

### EMEA

Morgan Advanced Materials  
United Kingdom, Germany,  
France, Italy, Spain, Poland,  
UAE, South Africa  
[sales.tcemea@morganplc.com](mailto:sales.tcemea@morganplc.com)

### Americas

Morgan Advanced Materials  
Thermal Ceramics Inc  
2102 Old Savannah Road  
Augusta  
Georgia 30906  
USA  
T +1 (706) 796 4200  
[marketing.tc@morganplc.com](mailto:marketing.tc@morganplc.com)

### Asia

Morgan Advanced Materials  
Morgan Ceramics Asia Pte Ltd  
150 Kampong Ampat  
05-06A, KA Centre  
368324  
Singapore  
T +65 6595 0000  
[asiasales@morganplc.com](mailto:asiasales@morganplc.com)