Specialty Graphites for High-Temperature Furnaces

- Advanced material, equipment, and process solutions
- Engineered for customers from more than 35 industries
- Tailor-made from the most comprehensive product portfolio
- In-depth production and material knowledge
- Consistent high quality, performance, and service
- Attractive total cost of ownership

Broad Base. Best Solutions.
Advanced solutions enable our customers to get ahead.

SGL Group offers advanced solutions – even for challenging applications. We understand the specific requirements of our customers and combine in-depth production, material, and engineering knowledge with the most comprehensive specialty graphite portfolio. This makes us the partner of choice to leading companies in many different industries.

Exceptional resistance to heat and corrosion, high purity and mechanical strength are just a few of the outstanding properties which our materials offer. Specialty graphite products from SGL Group achieve optimal results where other materials fail. No matter what your specific requirements might be, we will identify the best solution from the most comprehensive range of specialty graphites.

- Fine grain graphite: isostatic, vibration-molded, die-molded, extruded
- Expanded natural graphite
- Carbon fiber-reinforced carbon (C/C)
- Soft and rigid graphite felts
- Silicon carbide-coated graphite materials

Additionally we use other materials like PTFE, silicon carbide, and specialty metals.

With our portfolio and technical know-how spanning more than 35 different industries, we engineer tailor-made solutions in close partnership with our customers.

SGL Group covers the entire value chain of specialty graphite production, including raw material processing, semi-finished product manufacture, precision machining, purification, and coating. When it comes to engineering of equipment and process solutions our service range makes the difference: We offer mechanical and process design, production, assembly, commissioning, and service – all from a one-stop shop.

This is how we control and ensure the consistent high quality, reliability, and performance of our products – and enable our customers to become more competitive. Challenge us. We are there for you worldwide.

Specialty graphite solutions for high-temperature furnaces

Innovative, high-grade specialty graphite solutions are essential for building high-performance, high-temperature furnaces. The optimized components and materials we use make us a sought-after partner of leading original equipment manufacturers and suppliers in the field of vacuum and inert gas furnaces for heat treatment.
Specialty graphites – made by SGL Group.

Materials and solutions for high-temperature furnaces.

Our specialty graphite products prove themselves with their outstanding technical properties and optimum results: from warp-free work pieces to expedited process steps and lower energy consumption. Our materials and components, such as heating elements, insulations, heat shields and charging systems, increase the performance of our customers’ systems and processes in a wide range of applications and industries. We offer tailor-made solutions for specific applications, as well as high quality standards in accordance with ISO 9001, to meet the demanding requirements of original equipment manufacturers (OEM) and operators of high-temperature furnaces.

Fields of application:
- Vacuum furnaces
- Inert gas furnaces
- Heat treatment (hardening, carbonization, brazing, etc.)
- Carbon fiber production
- Cemented carbide production
- Sintering applications
- Technical ceramic production
- CVD/PVD coating

SIGRAFINE® is the new brand name for our fine-grain graphites, previously known under the names RINGSDORFF®, SIGRAFORM®, SIGRAMENT® and CRYSTA-SIL®.

Materials made of carbon and graphite
- SIGRAFINE®
  - Isostatic, extruded and vibration-molded graphites
- SIGABOND®
  - Carbon fiber-reinforced carbon (C/C)
- SIGRATHERM®
  - Carbon and graphite felts

Products of the SGL Group
- Heating elements and systems, structural parts and power supply lines, muffsles and susceptors
- Charging racks, charging plates, electrical heating elements and structural parts
- Rigid and soft felts for thermal insulation
**Products for high-temperature furnaces (vacuum and inert gas furnaces)**

<table>
<thead>
<tr>
<th>Components</th>
<th>Products</th>
<th>Graphite isostatic</th>
<th>extruded</th>
<th>vibration-molded</th>
<th>C/C</th>
<th>Rigid felt</th>
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<th>Graphite foil</th>
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<td>Heating elements and systems</td>
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**Products for hard metal and special ceramic production (powder metallurgy)**

| Charging elements                  | Sintering plates        | ● | ● | ● |
|                                    | Boats                   | ● |
| Heating systems and structural components | Heating tubes         | ● | ● |
|                                    | Contact bridges         | ● | ● |
|                                    | Hot press dies          | ● | ● |
|                                    | Rollers                 | ● | ● |
|                                    | Susceptors              | ● | ● |

**SIGRABOND®/SIGRAFLEX®**
- C/C / graphite foils
- Graphite foils

**SIGRAFLEX®**
- Carbon fiber-reinforced silicon carbide (C/SiC)

**SIGRASIC®**
- Composite material for heat shields
- Foils and laminated sheets as insulation felt coating
- Charging equipment, charging plates and structural parts
High-temperature materials for electrical heating

Specialty graphites prove their value in electrical heating systems thanks to their unique properties:

- Outstanding thermal stability
- High mechanical strength
- Good electrical and thermal conductivity
- Excellent resistance to thermal shock and corrosion
- High material purity
- High electrical load capacity
- Uniform temperature profile
Heating elements and systems

Various sectors of industry place extremely high demands on heating elements in high-temperature systems. In particular, heating the work zone of industrial furnaces is subject to a wide variety of system specifications that must be precisely coordinated to the individual processes.

In addition to the necessary resistance to high temperatures, high electrical load capacity and great mechanical strength, materials for heating systems should also be chemically pure and resistant to aggressive media, as well as to thermal shock. Economic aspects must also be factored in, such as optimizing work zones by using space-saving heating systems tailored to the facilities, low mass, long service life and maintenance-friendly assembly.

Graphite and C/C heating elements boast impressively long service life – even at high temperatures.

Whereas the use of metals and alloys in heating elements is generally limited up to 1600 °C (2900 °F), fine-grain graphites and carbon fiber-reinforced carbons are reliable at temperatures of up to 2800 °C (5100 °F), thanks to their great thermal stability in vacuum and inert gas atmosphere.

Even at high temperatures, graphite heating elements do not become brittle due to recrystallization or age-related coarse grain formation.

The fact that their strength increases as temperatures rise, yet their resistance to thermal shock is retained, is another advantage.

High material purity and resistance to chemicals protect the charging material from corrosion.

Heating elements made of graphite and C/C are resistant to aggressive media such as fluorine, chlorine and their hydrogen-containing compounds. They are also corrosion-resistant in contact with molten glass and many metals such as aluminum, lead, germanium, gold, cadmium, copper, mercury, silver, zinc, tin and alloys thereof.

We have developed special varieties of graphite to meet any and all requirements.
We select the right material for the application and handle configuration and manufacturing of heating elements for our customers. The following specialty graphites are used in the process:

- SIGRAFINE® MNC and MNT
- SIGRAFINE® HLM
- SIGRAFINE® R7300
- SIGRABOND® Standard, Premium and FilWound
- SIGRAFLEX®

*High-temperature furnaces equipped with an extremely durable SIGRAFINE graphite heating cage*
The specialty graphites SIGRAFINE MNC and MNT were specially developed for use as electrical resistance heating elements. They feature a very homogenous structure which enables a uniform temperature profile. The highly compressed surface is retained during the molding process, which makes SIGRAFINE heating tubes clearly superior to machine-processed tubes. Moreover, the heating core is protected from overheating, even at high temperatures.

- Lengths of up to 3000 mm (118”)
- Wide range of diameters available
- Relatively low wall thicknesses
- Long service life

SIGRAFINE graphite heating tubes – thermal shock-resistant, durable, efficient

SIGRAFINE, our specialty graphites, are used for heating elements as well as for structural and bearing elements in furnace construction.

- Heating elements
- Electrical connection contacts
- Contact bridges

The combination of SIGRAFINE HLM as contact bridges for SIGRAFINE MNC heating tubes make an ideal system solution to extend service life, and can be used in virtually any heating system design.
We handle both design and production of graphite and C/C heating elements for our customers’ specific requirements and applications. Years of experience, cutting-edge processing centers and comprehensive material expertise are what make us an ideal partner.

**Our engineering know-how makes the difference.**

Unlike simple processors of materials, we offer all-round consulting services for your high-temperature facilities. We work with you to develop solutions to increase efficiency and save energy and adapt our materials and components to ideally suit your requirements. For instance, SIGRAFINE heating tubes can be operated with relatively low amperages, even at high temperatures, which can simplify the design of power supply systems.

SIGRABOND heating elements –
light, compact, high-performance

Heating elements made of SIGRABOND C/C material boast great mechanical strength, facilitating space-saving and finely-shaped geometries in lightweight construction. This reduces thermal mass, which results in shorter response times and enables shorter process cycles. In addition to panel heaters, intrinsically stable, large-diameter round heaters are possible.

- Extended service life
- Enhanced damage tolerance
- High vibration resistance
- Space-saving geometries
- Large diameters of up to 2000 mm (79”)
- Lengths of up to 2500 mm (98”)

**Recommended limits for specific electrical loadings**

**Mechanical strength of graphite as a function of temperature**

SIGRABOND panel heater

SIGRABOND cylindrical heater
SIGRATHERM® rigid and soft felts for insulation

Our carbon and graphite felts provide a slew of benefits for heat insulation and high-temperature furnaces:

- Consistent and effective insulation
- Furnace heats up and cools down faster
- Fewer fiber particles in the furnace atmosphere
- Shorter evacuation times
- Easy handling, even with large textures
- Simpler maintenance
**SIGRATHERM® rigid graphite felts**

Excellent shape retention, thermal shock resistant, erosion-proof.

SIGRATHERM rigid felts are a carbonized and graphitized insulation material made of carbon fiber. A carbon binder anchors the fibers to prevent them from being ripped out. This minimizes the amount of fiber particles which get into the furnace atmosphere due to high gas flow velocities. The material properties ultimately depend on the initial fiber used, the type and quantity of binder, degree of compression and thermal treatment.

Thanks to their high temperature resistance, our rigid felts can be used under inert gas or vacuum conditions from $10^{-3}$ to $10^{-5}$ mbar at temperatures of up to 2200 °C (4000 °F) – or even greater, if approved by our application technology department.

The material’s low heat conductivity means that even thin layers of rigid felt can achieve good insulation results, and rigid graphite felt neither shrinks nor contracts under ordinary operating conditions. This means that it will not form any cavities, channels or hot spots, and its insulation remains consistent all the way through.

**SIGRATHERM helps expedite processes and increase productivity.**

The rigid felt insulation has low mass and low heat capacity thanks to its low density. This allows the furnace to heat up and cool down faster. Moreover, its low specific surface area minimizes adsorption of gases, vapors and moisture, providing for short evacuation times in vacuum furnaces.
SIGRATHERM® insulation panels

Excellent shape retention, erosion-proof, easy to process.

SIGRATHERM MFA rigid felt panels and rigid felt composite panels simplify insulation installation for vacuum and inert gas furnaces. Their high shape retention facilitates self-supporting design and ensures consistent, uniform insulation properties. Labyrinth or tongue-and-groove joints make it easy to connect SIGRATHERM MFA panels with one another, thus allowing large-format structures.

Dimensions:
- 1524 x 1219 mm (60” x 48”)
- Thicknesses of 20 – 400 mm (3/4” – 16”)

Compound panels and coating:
- Foil coating on both sides (MFA-FF)
- C/C coating on both sides (MFA-CC)
- Foil and C/C coating on both sides (MFA-FCCF)
- SC coating as edge and erosion protection

Edge protection delivers added dependability. We recommend SIGRABOND edge protection for machined edges or SIGRATHERM SC coating which can be used to cover panel and cylinder edges – can also be applied on-site. SC coating is made of carbon-based filling materials and binders which are suspended in water.

† MFA: uncoated rigid felt panel.
Application: insulation

† MFA-FF: rigid felt compound panel coated with SIGRAFLEX foil on both sides.
Application: insulation, radiation reflection to the furnace interior, erosion protection, convection barrier

† MFA-CC: rigid felt compound panel coated with SIGRABOND C/C on both sides.
Application: insulation, extra shape retention

† MFA-FCCF: rigid felt compound panel coated with SIGRABOND C/C and SIGRAFLEX foil on both sides.
Application: insulation, extra shape retention, radiation reflection to the furnace interior, erosion protection, convection barrier
SIGRAFLEX foils as convection barrier and for reflecting heat radiation. SIGRATHERM MFA-FF compound panels combine the good insulation properties of rigid felt with the reflective properties of SIGRAFLEX foil. The graphite foil is already permanently bonded to the insulation felt when shipped. It serves as a convection barrier for gases and additionally reflects the heat radiation of the heating elements into the furnace interior.

Optimum surface protection from mechanical influences. SIGRATHERM MFA-CC compound panels are coated in a fabric made of carbon fiber-reinforced carbon (C/C) to provide reliable surface protection from mechanical damage. This protects the insulation from erosion at high gas velocities and keeps it safe from damage during loading and installation work.

Other products:
- SIGRABOND heat shields
- SIGRABOND Mechanical fasteners
We deliver ready-to-use components such as tailor-made cylinders in virtually any length and diameter. Thanks to the wide range of production methods we use, there is practically no limit to the dimensions of our cylinders. We’ve developed optimized connection solutions for both axially- and radially-segmented insulation cylinders to meet customer-specific requirements for large-format cylinders.
Segmented cylinders:
- Greatest diameters and lengths
- Uniform insulation properties
- Foil and C/C coating possible on both sides
- Easy assembly
- Supports replacement of individual segments

Wrapped cylinders:
- Uniform insulation properties
- Can be used as a sandwich cylinder for pressure sintering furnaces
- Foil and C/C coating possible on both sides and in intermediate layer

SIGRATHERM MFA
Segmented cylinder:
- Diameter: unlimited
- Height: unlimited
- Wall thickness: max. 150 mm (6")

SIGRATHERM RFA
Wrapped cylinder:
- Diameter: max. 2000 mm (79")
- Height: max. 2500 mm (98")
- Wall thickness: max. 300 mm (12")

SIGRATHERM RFA
Sandwich cylinder:
- Diameter: max. 2000 mm (79")
- Height: max. 2500 mm (98")
- Wall thickness: max. 300 mm (12")

Thermal conductivity of SIGRATHERM MFA/RFA as a function of temperature (inert gas atmosphere)

Max. application temperature 2200 °C (inert gas atmosphere or vacuum)
SIGRATHERM®
soft carbon and graphite felts

Flexible, oxidation-resistant, efficient.

Our soft graphite felt is indispensable when it comes to meeting maximum requirements for insulation properties.

SIGRATHERM KFA soft carbon felt (up to 1000 °C/1800 °F)
SIGRATHERM GFA soft graphite felt (up to 2200 °C/4000 °F)

Our soft carbon and graphite felts feature very low thermal conductivity thanks to our special manufacturing processes. This makes them ideal for insulating resistance- and induction-heated vacuum furnaces and furnaces with inert gas atmospheres. Here are a few examples:

- Induction furnaces
- Degassing and carburizing furnaces
- Brazing and annealing furnaces
- Sintering furnaces for hard metals
- Carbon fiber furnaces
- Graphitizing furnaces with temperatures exceeding 2000 °C (3600 °F)

SIGRATHERM GFA soft graphite felts are made by graphitizing our SIGRATHERM KFA soft carbon felts. This reduces their specific surface area, which reduces pumping times in vacuum furnaces and shortens processing time.

SIGRATHERM soft felts are supplied in standard rolls from 25 to 30 m (82’ to 98’), in widths of 1220 and 1270 mm (48” and 50”), and in thicknesses from 2.5 to 12 mm (0.1” to 0.5”). What’s more, we also make soft felts in sizes tailored to the individual requirements of our customers.

The spectrum of applications goes far beyond thermal insulation.

Beyond thermal insulation, SIGRATHERM soft felts have proven themselves as a material solution for many other applications:

- Filter applications
- Catalyst support
- Porous electrodes

This is the result of close collaboration with raw material processing companies and end users, as well as our long-standing experience with high-temperature applications and our extensive material expertise.
Our SIGRATHERM soft felts uniquely combine textile, chemical and thermal properties.

**Low thermal conductivity:** Our soft graphite felts have lower thermal conductivity than metallic heat shields or loose insulation material such as carbon granulate. They thus achieve energy savings of up to 75%.

**Low heat capacity:** The insulation layer has low mass thanks to the low material density. This allows the furnace to heat up and cool down faster.

**High-temperature resistance:** Our soft graphite felts are thermally stable up to 2200 °C (4000 °F) in inert gas atmospheres and vacuum, and up to 350 °C (660 °F) in oxidizing atmosphere.

**Favorable resistance:** Does not cause coupling in inductive fields up to 12 kHz.

**Advantageous surface structure:** SIGRATHERM soft graphite felts show hardly any wetting or stickiness when used with molten glass or metal. They also have a low adsorption capacity thanks to their low specific surface area. If needed, surface area can also be enlarged through partial oxidation.

**Trouble-free processing:** All our soft felts are easy to cut with knife and shears, making them very easy to adapt to small curvature radii.

**High degree of purity:** Our soft graphite felt’s low sulphur content protects pump oils from contamination in vacuum operation, while its low ash content prevents afterglow. Our rigid graphite felts also support insulation applications in the semiconductor industry.

**Exceptional homogeneity:** Thanks to their smooth surface and low thickness, our soft felts will not ripple, even over great lengths (25 m/82’). They remain uniformly even, thus providing consistent insulation throughout.

**No electrostatic charging:** SIGRATHERM soft felts can be used in conjunction with plastic in composite materials.
SIGRABOND® components and semi-finished products for furnace construction

SIGRABOND is a heavy-duty, temperature-resistant, fiber-composite material. We use it to make semi-finished products as well as system components such as charging systems for a wide range of applications:

- Gas carburizing
- Vacuum brazing
- CVD/PVD coating
- Sintering applications
- Heat treatments of all kinds in vacuum and inert gas atmospheres
**SIGRABOND® charging systems**

*Lightweight, sturdy, efficient.*

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**Density of different high-temperature materials**

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<thead>
<tr>
<th>Material</th>
<th>Density [g/cm³]</th>
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<td>SIGRABOND Performance</td>
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<tr>
<td>Cast steel</td>
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<td>Molybdenum</td>
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**Typical hot bending strength of various high-temperature materials**

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<th>Temperature [°C/°F]</th>
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<th>Cast steel</th>
<th>Molybdenum</th>
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- **Low density of SIGRABOND C/C**: reductions in weight shorten processing times and increase efficiency
- **One of the material’s most important benefits**: its strength increases significantly as temperatures rise

Charging systems made of our SIGRABOND carbon fiber-reinforced carbon display important advantages in comparison with high-temperature steel, molybdenum or nickel-chrome alloys, especially in high-temperature applications:

- Increasing strength as temperatures rise
- Greater thermal stability and resistance to thermal shock
- Significantly longer service life
- Lower density
- Considerably less weight

Higher process efficiency and considerable cost reduction. The material’s increased strength at rising temperatures and outstanding resistance to embrittlement markedly extend the material charging system’s service life and reduce maintenance expenses. Moreover, its high heat resistance in conjunction with the characteristic low density of fiber-composite materials allows streamlined design for lightweight structures, even under great stress.

The result: up to 100% greater load capacity, shorter process times and reduced energy expenses. The low weight also makes charge carriers easier for a single person to handle.

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- **SIGRABOND Performance** charging plate
  - system with higher stiffness
The benefits of SIGRABOND C/C charging systems:

- Shorter process times and lower energy consumption
- Increases the system’s load capacity
- Eliminates the need to adjust the system
- Extended service life
- Easy handling thanks to low weight
- Enables automated loading

SIGRABOND Performance – specifically developed for charging systems. With SIGRABOND Performance, we have developed a C/C material which is optimized to meet charging system requirements, especially for use in modern heat treatment systems. High flexural modules and flexural strength enable more streamlined system designs and increase capacity.

Standard charging system with modular configuration. The modular SIGRABOND configuration offers standard charging frames and plates for flexible heat treatment of varying components. They are available in the following dimensions:

- 600 x 450 mm (24” x 18”)
- 900 x 600 mm (36” x 24”)
- 1200 x 900 mm (48” x 36”)

They can be combined with one another and their height rapidly adjusted, thanks to their simple stanchion design.

Maximum reliability, even in automated production processes.

SIGRABOND Performance even retains its shape under rapidly fluctuating temperatures thanks to its strength at high temperatures and great resistance to thermal shock. It also features low thermal expansion and high creep resistance, ensuring maximum material reliability, even in automated production processes.

Our SIGRABOND charging systems do not show any signs of material fatigue or warping – even after hundreds of furnace cycles. The tool holders can be mechanically loaded and unloaded for years and years without problems. Time-consuming and expensive manual adjustment work is eliminated, scrap expenses are reduced, and productivity and cost-effectiveness are increased.
Fracture behavior of C/C.
Components made of fiber composite materials do not break abruptly under stress the way ceramics do. Neither do they exhibit the plastic behavior of metals when stressed beyond the elasticity limit. At first, only a few fiber strands in the C/C will tear under stress. Full failure will only occur when the material is subjected to further stress.

Dynamic strength at high temperatures.
One of SIGRABOND’s particular advantages lies in its dynamic strength at high operating temperatures. After $10^6$ to $10^7$ load cycles, its original strength will only decrease by about 5%.

We provide tailor-made solutions for customer-specific applications.
We optimize our SIGRABOND charging systems to meet our customers’ individual requirements, such as multi-level structures or special work piece arrangements.

Our engineering expertise and years of experience in the configuration and design of charging systems help us find the best solutions for our customers. To accomplish this, we use the finite element method and cutting-edge laboratory equipment, as well as state-of-the-art CAD modeling programs and load calculation simulations.

We offer a special material for processes using oil quenching hardening.
Materials used in processes with oil quenching hardening should not have open pores. SIGRASIC, our special ceramic made of carbon fiber-reinforced silicon carbide, is specially designed for this demand. This material combines the benefits of ceramic with the favorable characteristics of carbon fiber material.

SIGRABOND Performance is equally well-suited for this purpose with its high fiber content and low porosity.
Optimization partner for processes and systems

We have successfully assisted one of our customers in designing a new charging system with charging plates based on SIGRABOND Performance. After calculating bending behavior and flexural strength using FEM analysis, we increased loading volume by 50% in comparison with the previous charging system. What’s more, the use of SIGRABOND Performance enabled a plate structure with markedly lower deflection.

This is just one example of an application-specific optimized solution from SGL Group.
Structural components, fasteners and charging equipment

High strength, temperature resistance and reliability.

The SIGRABOND C/C materials:

- **Standard**: for heating elements and furnace linings
- **Premium**: for heating elements and structural components
- **Performance**: for charging frames and systems
- **FilWound**: for cylinder components
- **Mechanical**: for fasteners

We also use our carbon fiber-reinforced composite material SIGRABOND to make semi-finished products, furnace components and fasteners for high-temperature applications. Our materials are either fabric- or unidirectional-based, depending on stress conditions. They also differ in terms of flexural strength and are supplied in all-purpose, high-strength or high-rigidity varieties, based entirely on the specific requirements in question.

SIGRABOND semi-finished products and furnace components. Our portfolio includes plates and L and U profiles in a wide range of standard thicknesses and lengths. We also make structural components according to customer-specific requests such as:

- Fan wheels for ventilators in vacuum and inert gas furnaces
- Thick-walled hot press matrices
- 3D-C/C crucibles

SIGRABOND semi-finished plates are available in plate thicknesses from 0.75 to 30 mm (0.03” to 1.2”) and in the following standard sizes. More sizes and thicknesses are available for our customers’ individual needs upon consultation.

- 1220 x 1220 mm (48” x 48”)
- 2450 x 1220 mm (96” x 48”)

SIGRABOND tubes and cylinders can be laminated (SIGRABOND Standard/Premium), wound (SIGRABOND FilWound) and manufactured based on specific customer requirements. Maximum dimensions for tubes and cylinders:

- Diameter: 2000 mm (79”)
- Length: 2500 mm (98”)
- Wall thickness: 100 mm (4”)
SIGRABOND profiles for lining high-temperature furnaces.
In combination with SIGRABOND semi-finished plates, our profiles provide ideal protection for the sensitive insulation in furnace chambers.

- U-profiles up to 2000 mm (79”) in length
- L-profiles up to 2000 mm (79”) in length

SIGRABOND C/C lining products meet the highest standards for quality and material properties, and are specifically aligned with the application at hand.

SIGRABOND Mechanical connection elements for use in high-temperature furnaces.
Our customers’ large-scale components and assemblies are held together by SIGRABOND bolts and pins. They can be used for such purposes as fastening furnace lining plates and insulation elements made of SIGRATHERM rigid or soft felt.

SIGRABOND Mechanical has been specifically developed for fasteners in multi-axial stress situations. The material is particularly well-suited for use in high-temperature applications, since its strength increases as temperatures rise.

Our portfolio includes pins, rods, threaded rods, nuts, washers, countersunk and hammer-head screws.
The dimensions conform to general standards for fasteners, whereby our standard portfolio includes metric threading from M6 (1/4” -20 UNC) to M24 (1” -8 UNC). Other types of threading can be produced upon request.

SIGRAFINE fine-grain graphites for sinter trays.
Tailor-made non-warping sinter trays made of SIGRAFINE fine-grain graphites may be an alternative to C/C, preferably in the powder metal industry, where high mechanical strength and thermal shock resistance play a secondary roll.
SIGRAFLEX®
for heat shields

Our flexible graphite foils and sheets are widely used in high-temperature applications thanks to their unique properties.

SIGRAFLEX foil is typically used for heat shields in high-temperature furnaces, as well as in combination with SIGRATHERM rigid graphite felt as insulation material.

Our SIGRAFLEX laminated sheets and ready-to-use composite materials made of SIGRATHERM rigid graphite felt and SIGRAFLEX foil have particularly proven themselves as interior wall lining for vacuum furnaces.
SIGRAFLEX foils and laminated sheets are made of expanded natural graphite and are manufactured without the use of binders or adhesives. They are used as heat shields and inner linings in high-temperature applications, as well as in a very wide range of other applications.

- Heating elements
- Lining for crucibles and casting molds
- External cladding for hot-press molds
- Protective strips for welding, soldering and sintering work
- Carrier material for separating thin metal films from the gaseous phase
- Protective material against laser beams
- Surface protection layer for thermal insulation
- Gas diffusion barrier in sandwich insulation

A SIGRAFLEX jacket protects graphite felt insulation from chemical corrosion and abrasion from high gas flow velocities. It also reflects heat radiation.
Products made of flexible graphite such as SIGRAFLEX foils and sheets feature superior properties.
These include anisotropy, electric and thermal conductivity, high temperature resistance, heat reflection and a soft surface impermeable to liquid and gas. More special features:

- Thermal stability in air up to 400 °C (750 °F), under reducing and inert atmospheres up to and exceeding 3000 °C (5400 °F)
- Excellent resistance to chemicals
- Smooth, reflective surface
- Unwettable by molten materials such as glass, ceramic or non-ferrous materials
- Impermeable to gas and liquid
- Easy to cut and punch out

The base material for producing SIGRAFLEX foils and sheets is natural graphite. This is converted into a graphite intercalation compound. Thermal treatment of the intercalation compound results in expanded, voluminous graphite flakes, which can be continuously pressed into flexible foils or finished rolls and sheets without the use of binders.

Vacuum and inert gas furnaces achieve a high degree of temperature uniformity thanks to the good thermal conductivity in all directions and the reflective property of SIGRAFLEX flexible graphite. The smooth material surface allows furnace applications at high gas velocities to cool down without damaging insulation. SIGRAFLEX foils and laminated sheets can be applied directly to insulation as heat shields for high-temperature furnaces or used as separate heat shields.
SIGRAFLEX/SIGRAFLEX heat shields

Our heat shield solutions made of a combination of C/C and graphite foil provide dual protection for insulating vacuum and inert gas furnaces. Firstly, they provide protection from mechanical effects such as damage during loading; secondly, they reduce the insulation's moisture absorption and reflect the heat into the interior of the furnace.

Our heat shields are easy to handle and can easily be applied to existing insulation using C/C connection elements. Low thickness makes them flexible and easy to bend at low diameters.

SIGRAFLEX flexible graphite for heating elements

SIGRAFLEX laminated sheets with a specific electric resistance of 6–8 Ωµm can be used in strip form and meander-shaped large-area heaters in electrically heated vacuum and inert gas furnaces.

SIGRAFLEX flexible graphite makes a valuable addition to graphite and C/C heating element materials thanks to its low weight, high chemical resistance and trouble-free installation.

SIGRAFLEX flexible graphite heating elements are easy to structurally adapt to furnace systems in order to optimize usable furnace space. Moreover, the thin large-area heating system achieves a very homogenous temperature profile.

The heating element’s low thickness allows very short heat-up and cool-down cycles, an important factor for efficiency in high-temperature processes.
We will find the best solution – in partnership with you.

The fascinating potential of carbon as a material excites us and inspires us to develop optimum solutions in partnership with our customers.

With our comprehensive material portfolio and valuable specialist know-how, we can manufacture tailored products – even for the most challenging applications.

Consistently high quality, a global presence, innovative strength, and the extensive experience of our employees make us a reliable partner to our customers.

Whatever challenges you face, together we will find the best solution.

- Unique product portfolio
- Innovative technologies and solutions
- Production sites close to sales markets
- Technology & Innovation Center in Germany with international networks

We have wide-ranging expertise in raw materials, advanced manufacturing processes, and long-standing application and engineering know-how. We have a comprehensive portfolio of carbon, graphite, and carbon fiber products and our integrated value chain covers everything from carbon fiber to composites. With a global sales and distribution network and modern production sites in Europe, North America, and Asia, we are close to our customers throughout the world.

We use this broad base to offer our customers the best solutions possible. That’s how we live up to our claim: Broad Base. Best Solutions. This claim is also upheld by our corporate SGL Excellence philosophy of continuous improvement.

More information can be found by visiting:
www.sglgroup.com

Further information available at:

Facebook: SGL Group
YouTube: SGL Group
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