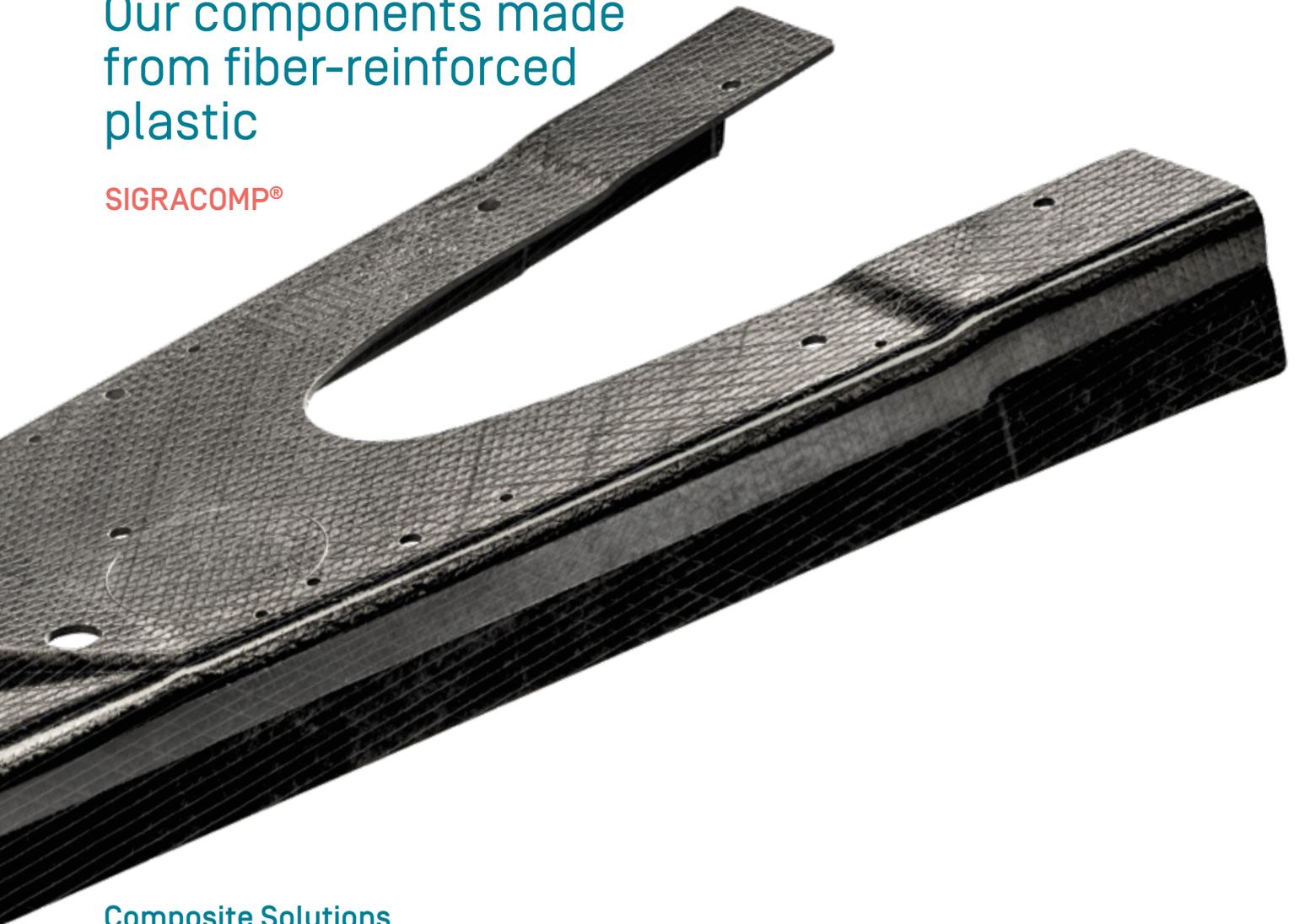




The Weight Optimizers

Our components made from fiber-reinforced plastic

SIGRACOMP®



Composite Solutions



$\rho \approx 1.55$

SIGRACOMP[®] components Lighter, stronger, stiffer

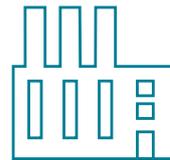
Our SIGRACOMP components made from carbon fiber-reinforced plastic have an impressively low density of only 1.55 g/cm³ (with HT fibers and a fiber volume content of 60%). This is combined with excellent mechanical properties such as high strength and stiffness. Because SIGRACOMP is considerably lighter than comparable construction materials, it solves weight problems in many applications and allows maximum mass optimization for new designs. Intelligent solutions from SGL Carbon – real weight optimizer.

g/cm^3



Our components made from fiber-reinforced plastic

Our components are used in many different industries. As a customer, you can benefit from our expertise in all processing stages. The carbon fibers we produce ourselves in Europe and North America form the basis for all composite applications.



Market segments of our Business Unit Composite Solutions

Typical applications

Automotive

- Structural components
- Design components
- Chassis components
- Drive train

Industrial Applications

- Medical technology
- Robotics and automation technology
- Measuring technology and optics
- Mechanical engineering

Products of SGL Carbon

- A, B, C pillars and sills
- Struts [e.g. windshield cowl, roof bow, strut brace]
- Roof modules
- Trunk lids
- Leaf springs
- Wishbones and stabilizers
- Battery casings

- X-ray patient supports
- Robot arms
- Sensor tubes
- Lifting beams

Materials used by SGL Carbon

- SIGRAFIL® continuous carbon fiber tows
- SIGRATEX® woven, unidirectional, and multiaxial fabrics
- SIGRAPREG® prepregs and TowPregs
- Thermoplastic composite materials

- SIGRAFIL® continuous carbon fiber tows
- SIGRATEX® woven, unidirectional, and multiaxial fabrics
- SIGRAPREG® prepregs and TowPregs

Advantages for you

In high-tech applications requiring high strength and stiffness combined with light weight, our fiber-reinforced plastic components are indispensable. Carbon fiber-reinforced plastic (CFRP), in particular, is considerably lighter than aluminum or steel, while being extremely durable.

Our fiber-reinforced components are therefore used in many sectors, such as the automotive, aerospace, and energy industries, as well as other industrial applications.



Aerospace

- Primary and secondary structural components
- Interior components

-
- Payload fairing
 - Tanks
 - Bulkheads
 - Aircraft seat components
 - UAV structural components

-
- PANOX® oxidized PAN fibers
 - SIGRAFIL® continuous carbon fiber tows
 - SIGRATEx® woven, unidirectional, and multiaxial fabrics
 - SIGRAPREG® prepregs and TowPregs
 - Thermoplastic composite materials
 - Thermal insulation
-



Energy

- Renewable energies

-
- Spar caps for wind turbines
 - Pipes and risers for oil and gas
 - Electric cables
 - Pressure vessels

-
- SIGRAFIL® continuous carbon fiber tows
 - SIGRATEx® woven, unidirectional, and multiaxial fabrics
 - SIGRAPREG® prepregs and TowPregs
-

From material to finished component

Benefit from our fiber products in all processing stages: from precursors through fibers, textiles, and pre-impregnated products to finished components. We, in partnership with you, find the right materials for your application, develop new components, and support implementation of efficient production – for both high and low volumes.



Know-how across all processing stages

Highest product quality and security of supply

We cover the entire carbon fiber value chain: from raw material we produce ourselves through all intermediate stages to the finished components and the corresponding production process chain. With our production and processing expertise and comprehensive material know-how, we can guarantee the highest product quality and security of supply.

Broad material base

We have a wide range of materials at our disposal to meet the many and varied requirements of different applications. For example, we use continuous carbon and glass fibers as well as textile, pre-impregnated, and thermoplastic materials in our components.

Lightweight design solutions ready for serial production

In component development, you can benefit from our long-standing experience. We are familiar with the various industries and their requirements. We would be pleased to design and develop completely new components in partnership with you and have the capability to produce them in high as well as low volumes. In our Lightweight and Application Center (LAC), we create lightweight design solutions ready for serial production. In doing so, we draw on our wide range of materials and expertise across all processing stages from fibers to the final lightweight structure.

Our material portfolio

- PANOX® oxidized PAN fibers
- SIGRAFIL® carbon fibers
- SIGRATEX® woven, unidirectional, and multiaxial fabrics
- SIGRAPREG® prepregs and TowPregs
- Thermoplastic composite materials



↑ Unique integrated value chain

Production of the ideal material

Our carbon fiber-reinforced plastic is the ideal material for lightweight design. It has the following properties:

- Low intrinsic weight
- High strength and stiffness
- Excellent fatigue strength
- Good vibration damping
- X-ray transparency
- High chemical resistance
- Low thermal expansion
- Corrosion resistance

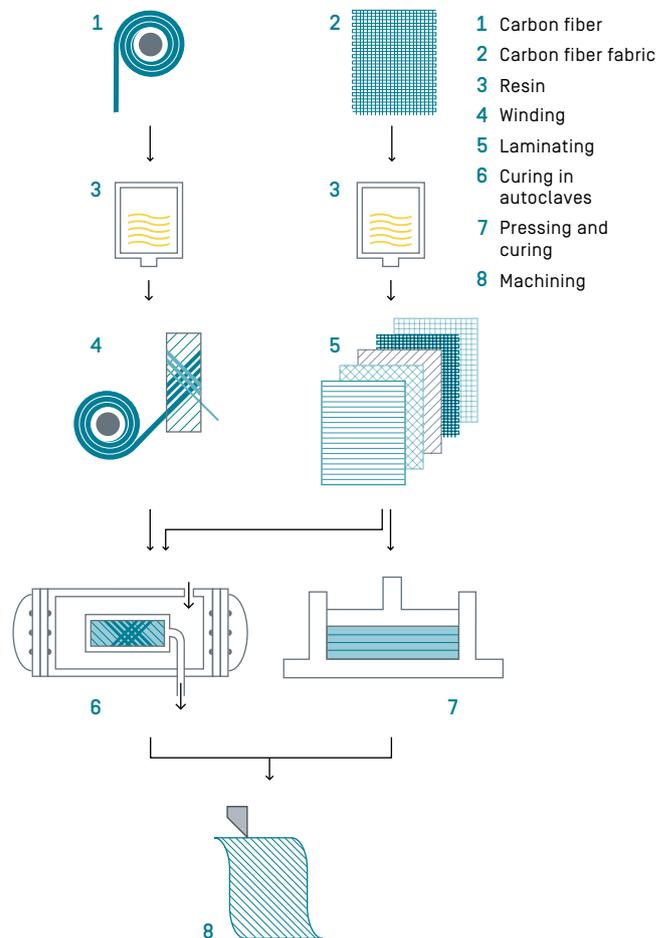
For industrial applications, we produce our SIGRACOMP CFRP components right from the prototype stage to serial manufacture. Depending on the specific requirements, we use and prescribe one of the following production technologies:

- Prepreg compression molding
- Autoclave technology
- Winding methods
- Blowing methods
- Preform production
- RTM process
- Wet pressing
- Braiding
- Tape laying
- Fiber placement

Production process

As the diagram shows, there are various routes in the production of components. The arrows indicate the sequence of the production steps and how they can be combined.

Example of the production process



Comprehensive solutions – from initial concept to implementation



↑ Concept development of a SIGRACOMP CFRP component

Component as well as material manufacturer

We work closely with you, our customer, to develop a new application. First of all, we discuss with you the range of materials available for the specific requirements. If required, we can also make a new semi-finished product for your application.

3D drawings and FEM analyses

The installation space required for the intended component and the loads to which it will be subjected are defined to establish a framework for component design. Then, we develop specific construction methods with the aid of 3D constructions and the latest FEM calculations for the particular material to be used. In this way, we provide you with an excellent decision-making basis for further development.

Production process is determined

In parallel to product development, we determine with you the most suitable production process. Besides process simulation, we also undertake industrialization of the relevant production process. We can produce prototypes or pilot series on request.

For optimum combination

Composites are increasingly being used in large-scale manufacture and combined with conventional materials such as steel and aluminum in ever more specialized applications. With our know-how and broad material base, we can develop the ideal solution specially for your application.

Optimization and quality control

To meet your requirements, we are continuously optimizing our products and processes:

- Mechanical and static testing of CFRP components
- Quality control during all stages of production and final inspection

Material properties

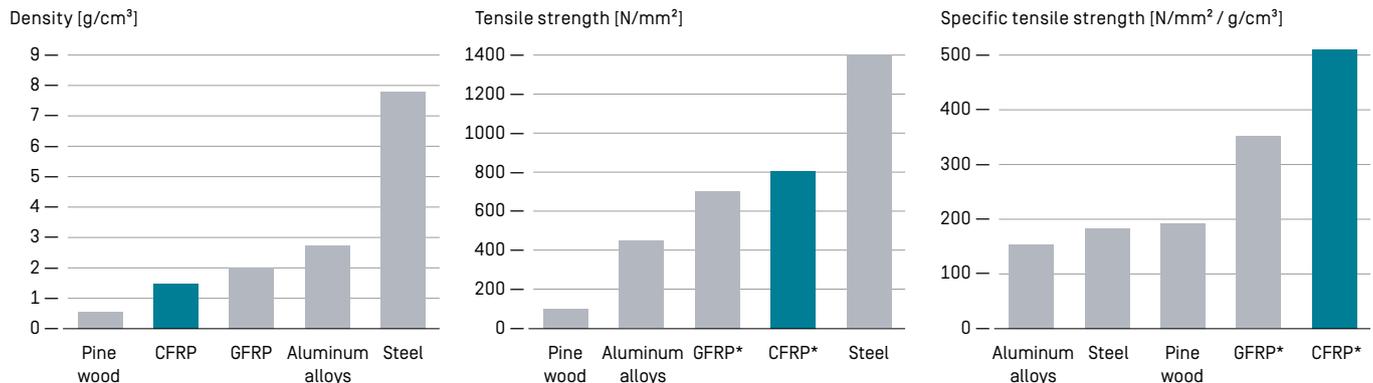
Genuine high-performance materials

Our fiber-reinforced plastics are materials consisting of several constituents: a base or carrier substance, known as the matrix, and a second, reinforcing material embedded in the matrix. For the latter, we use carbon fibers or glass fibers, depending on the application. The result: high-performance materials with exceptional properties, which we can tailor individually to suit requirements.

Highest specific tensile strength

CFRP composites have low density but also high tensile strength. In terms of specific tensile strength, they are number one, followed by GFRP composites. Other construction materials, such as steel and aluminum alloys, perform significantly worse in this respect. For this reason, CFRP materials dominate modern lightweight design in extreme-stress applications.

Properties of construction materials as compared with CFRP



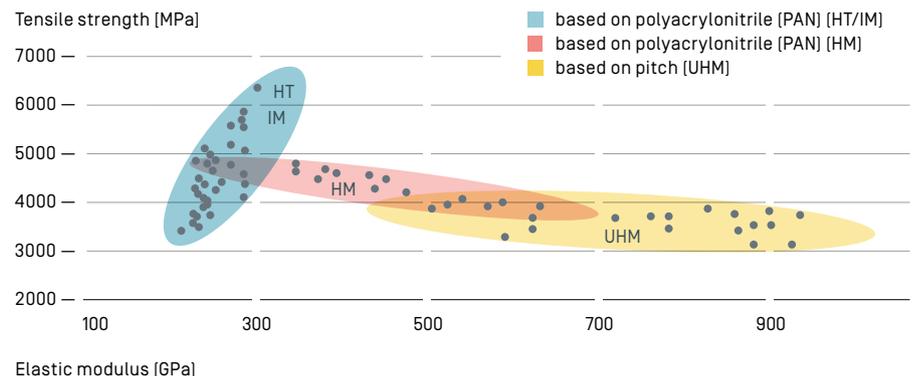
* Fiber orientation 0°/±45° = 1/1

Components based on all commercially available fiber types

Commercial carbon fibers today can be classified into two basic groups: high tensile fibers (HT) and ultrahigh modulus fibers (UHM). HT fibers cover 80% of the market. As the graph shows, we supply both fiber types, which we incorporate into our components according to the particular application requirements.

Commercially available fiber types

Specific tensile strength and tensile modulus of different carbon fiber types

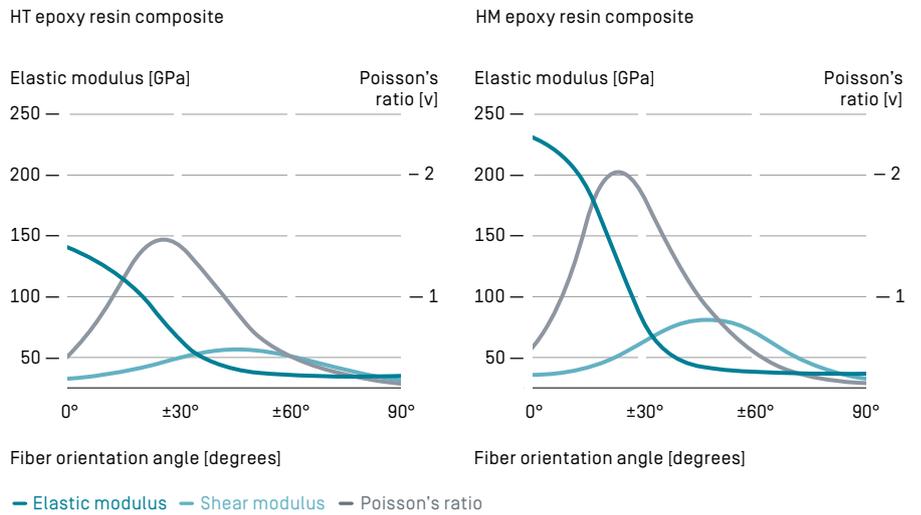


Fiber orientation is crucial

Fiber-reinforced composites are anisotropic, i.e. their properties differ according to fiber orientation. Their physical properties, such as elastic modulus or strength, vary as a function of the fiber orientation angle.

By changing the fiber orientation angle, composite properties can be adjusted

Elastic laminate properties of CFRP as a function of fiber orientation angle.

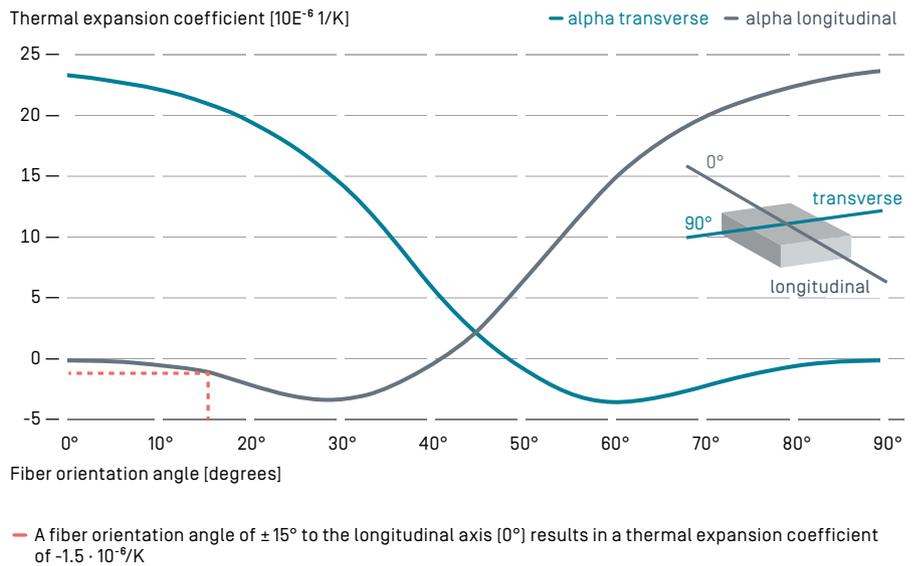


Even negative thermal expansion coefficients are achievable

The thermal expansion coefficient (TEC) of SIGRACOMP CFRP components can be adjusted within a certain range through the choice of fiber orientation angle, making it possible to achieve very low or even negative thermal expansion coefficients. This is important for optical precision instruments but also for all other components that have to be dimensionally stable.

Very low or negative thermal expansion can be achieved

Thermal expansion coefficient of HT CFRP as a function of fiber orientation angle.



Our composites can do more

Depending on the particular industry, materials have to meet different requirements. Our fiber-reinforced plastics can satisfy the demands of other industries just as well as the requirements of the applications detailed here.

Automotive

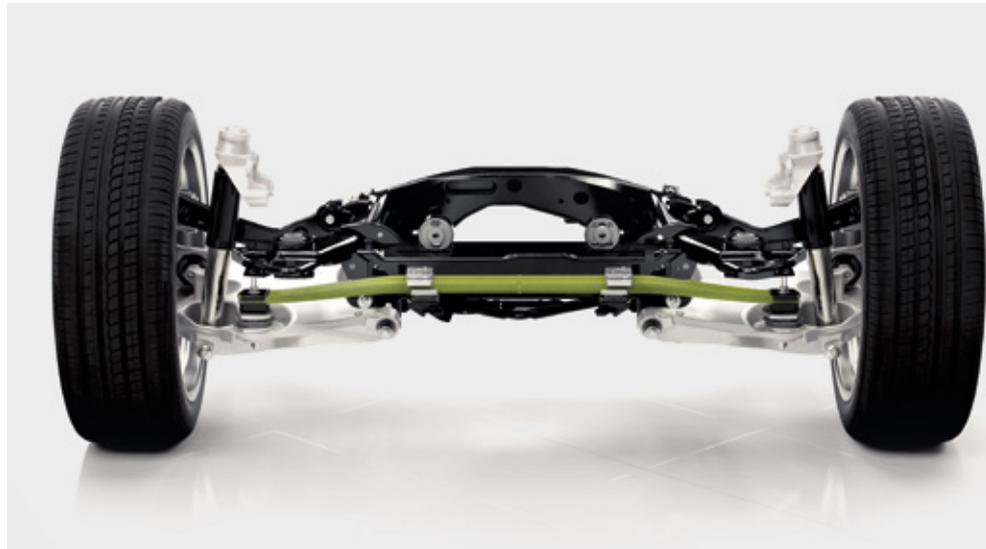
Components based on fiber-reinforced plastics reduce vehicle weight, hence reducing CO₂ emissions. For applications with highly specialized requirements, we use innovative hybrid composite structures. Our material systems and production technologies are designed in a manner that all components can be produced on a large scale.



Meeting targets more easily



↑ Automotive B pillar with local reinforcement. Produced from SIGRAPREG TowPreg by automated fiber placement, consolidated by isothermal compression molding



↑ Our glass fiber composite leaf spring not only reduces weight by more than 50% compared to its steel counterpart, but also offers advantages in vehicle handling and uses relatively less space

Meeting emission standards with composites

Even more than in the past, car manufacturers are working on reducing the weight of their vehicles. Only by doing so can they comply with CO₂ emission regulations. Since they are significantly lighter than conventional materials, it clearly makes sense to use more fiber-reinforced plastics for component development.

Effective hybrid structures

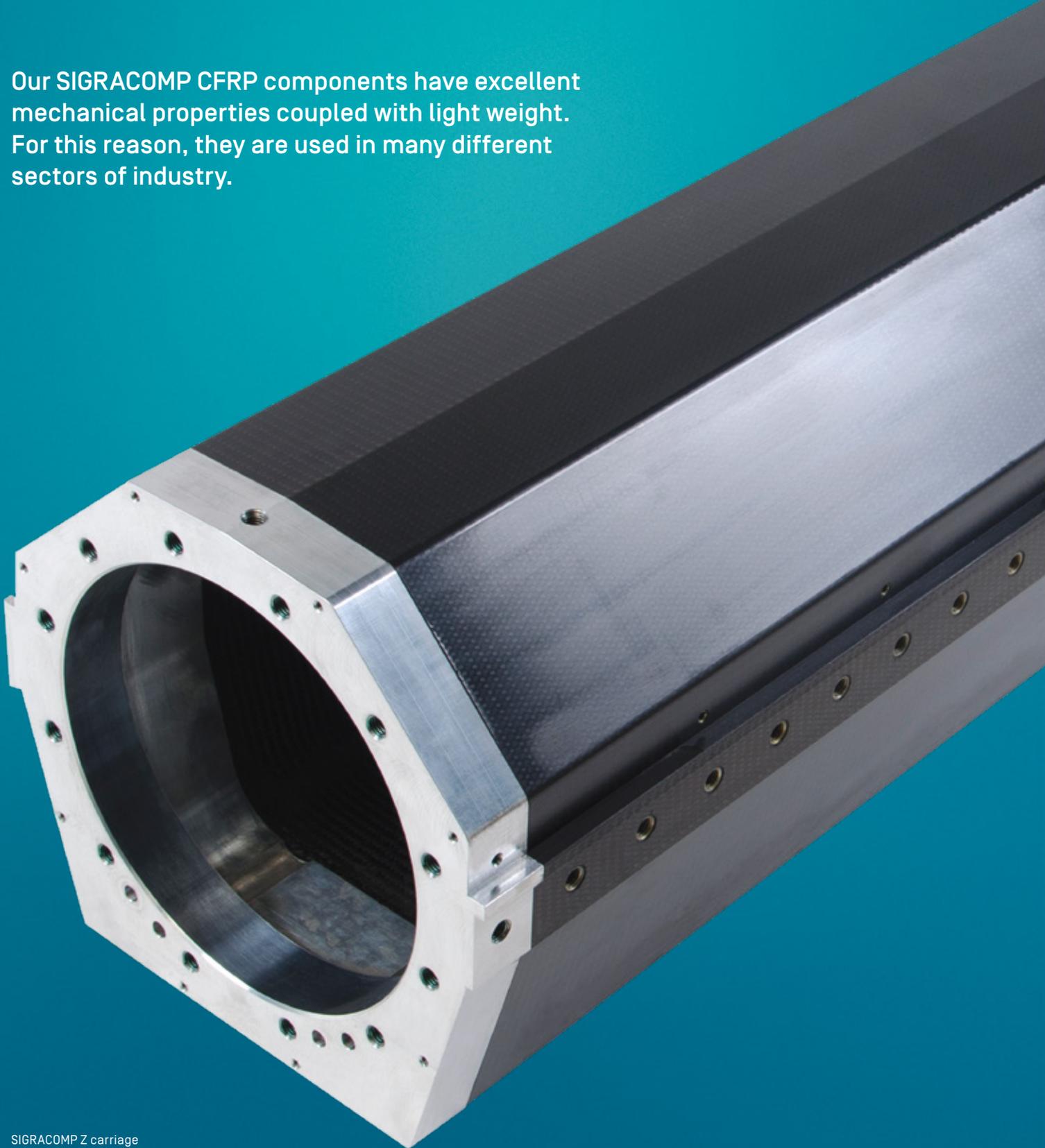
For more specialized applications, fiber-reinforced composites are being increasingly used in combination with conventional materials such as aluminum or steel. Hybrid composite structures that we develop on the basis of glass or carbon fibers are also gaining popularity in automotive applications. With these innovative composites, conflicting objectives such as light weight, high strength, and low cost can often be reconciled most effectively.

Optimized for large-scale manufacture

Our components for the automotive industry are usually produced in large-scale serial production. The relevant material systems and production technologies are optimized for this use. With fast cycles and optimized material use, we can produce extremely efficiently.

Industrial Applications

Our SIGRACOMP CFRP components have excellent mechanical properties coupled with light weight. For this reason, they are used in many different sectors of industry.



Opportunities for optimization

New applications with improved properties

Components based on carbon fiber-reinforced plastics offer a wealth of opportunities in machinery manufacture, measuring technology, robotics, and medical technology. Thanks to their unique material properties, they make it possible for widely diverse application requirements to be met.

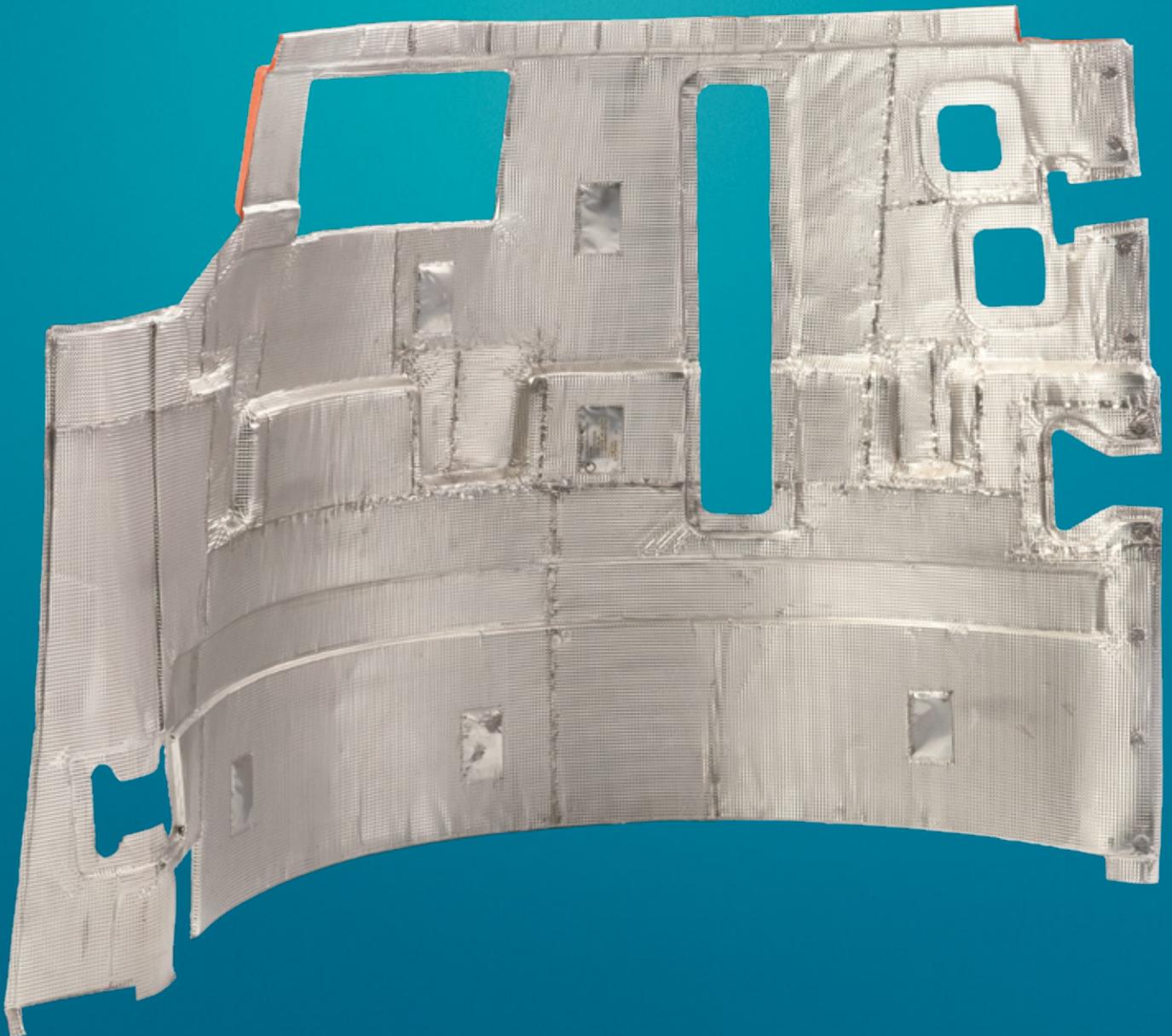
For example, individual parts can be lighter, machinery more compact, or output increased through faster cycles. We have the capacity to produce prototypes and in low volumes, and upon request, we can also set up pilot lines. You can also benefit from shorter automation time in production.

Applications for SIGRACOMP CFRP components

	Medical technology	Robotics and automation technology
Typical products	<ul style="list-style-type: none"> • X-ray tables • CFRP sandwich panels • CFRP holders • Accessories • Fixing devices • Transfer boards 	<ul style="list-style-type: none"> • Crossbars • Robot arms • Grippers of various designs
Advantages	<ul style="list-style-type: none"> • Low x-ray attenuation • Declaration of conformity under the German Medical Devices Law • Biocompatibility 	<ul style="list-style-type: none"> • Low intrinsic weight • Positional accuracy • High vibration damping • Excellent fatigue strength • High acceleration and speed possible
	Measuring technology and optics	Mechanical engineering
Typical products	<ul style="list-style-type: none"> • Sensor tubes • Columns • Optical scissors • Camera plates • Lens mounts 	<ul style="list-style-type: none"> • Rapiers • Connecting rods • Lifting beams • Bunching bows • Tool axles
Advantages	<ul style="list-style-type: none"> • Low thermal expansion [adjustable into the negative range] • Low intrinsic weight • High measuring accuracy • Dimensional stability • Positional accuracy 	<ul style="list-style-type: none"> • Low intrinsic weight • Excellent fatigue strength • Higher output • Lower energy consumption • Good chemical resistance

Aerospace

Components produced from fiber-reinforced plastics are becoming increasingly important in the aerospace industry. As experts in the manufacture of fiber products, we lead the field in fiber processing and can develop components to the serial production stage. Thermal insulation is a good example here.



Development of components to the serial production stage

Automated fiber processing

The demand for fiber-reinforced plastics in the aerospace industry is greater than ever. They are replacing conventional components and are often an important part of the material mix. We employ a very innovative process here, known as fiber placement. In this process, the fibers are automatically placed and cut, hence ensuring load-optimized fiber orientation and efficient use of material. The process is also attractive because it offers a higher degree of automation, which is increasingly required in production today.

Development of serial production-ready components from prototypes

For this purpose, we have established the Fiber Placement Center in partnership with the Fraunhofer IGCV (Fraunhofer Institute for Casting, Composite and Processing Technology). The Fiber Placement Center also works closely with the Lehrstuhl für Carbon Composites der Technischen Universität München (Department of Carbon Composites at the Technical University of Munich). The main site of this new development and production center is at our Meitingen facility. As our customer, you will be able to develop various production concepts and produce prototypes here in close collaboration with us. Henceforth, we can implement large-scale production of the fiber-reinforced components for you.

Available to other industries

Fiber placement is a technology from aerospace engineering, which we can now offer to other sectors at an industry-ready level.



↑ Fiber Placement Center at the Meitingen site

Advantages of fiber placement:

- High degree of automation in production
- High flexibility
- Efficient material use

Thermal insulation for aerospace technology

In the aerospace industry, thermal insulation has an important role to play, for example in engine cladding and the isolation of cabins. Fiber-based components with good insulating properties are used here. Our special insulating materials are processed into complex components and assemblies.

The materials used are optimum in terms of thermal and acoustic performance, service life, and weight and cost reduction. We tailor these insulation products to your requirements, enabling you to benefit from our extensive experience with insulating materials. As a leading global manufacturer, we produce components such as cladding, heat shields, and sewn cabin insulation.

Energy

Energy companies must ensure a reliable, flexible supply of energy to consumers. At the same time, cost pressures are increasing, and so are greater demands on efficiency. Genuinely high-performance materials are needed – in different sectors of the energy industry.



High-performance materials for a dynamic industry

Designed for the production process

Renewable energies account for a rising share of the energy supply. Production and use of conventional energy sources is becoming increasingly expensive. At the same time, pressure to reduce energy costs is growing and there is an even greater need for the supply of energy to be reliable, flexible, and highly efficient. To meet this challenge, increasing use must be made of high-performance materials like composites based on carbon fibers. With such materials, wind turbines can achieve higher performance, overland cables can be more efficient, and the exploration depths of conventional energy sources increased. For these to be possible, the material properties must meet the demands posed by specific requirements, specialized manufacturing processes and large-scaled production. With our specific material and process know-how, we are more than ready to meet these requirements.

Use in different industries

As the global supplier, we manufacture fiber products covering all processing steps. Through our knowledge and experience, we can guarantee the highest product quality.

For this reason, our carbon fiber composites can also be used in many sectors of the energy industry:

- In the production of renewable energy
- In the production of conventional energy sources
- In energy transport and storage

Wide range of applications

The range of applications is very diverse. Examples of typical products include:

- Rotor blade structures for wind turbines
- Pipes and risers for oil and gas production
- Electric cables
- Pressure vessels

Rotor blades capable of withstanding extreme stresses – low deflection, aerodynamically efficient

In many wind turbines today, our carbon fiber-based composites are already making an important contribution. Thanks to the high stiffness of these materials combined with their low density, they can be used to produce slender rotor blade structures capable of withstanding extreme stress. Efficient and economical mass production is now possible in these applications thanks to our specific material and process know-how.

Ideal for rotor blades of the future

Due to increasing energy demand and better cost efficiency (energy cost), wind turbines are being constructed with increasingly large rotor diameters. Blade lengths of over 80 meters are already a reality and blade lengths of over 100 meters are planned. The strength and stiffness of carbon fiber composites combined with their low density really pay off here.

Successful together

In our Lightweight and Application Center [LAC], together with our customers, we develop lightweight design solutions ready for large-scale production. While doing so, we draw on our wide material base and process expertise.

In the LAC's floor space of over 1500 m², the LAC team works on innovative lightweight structures and processes and produces prototypes and small lots. In this way, we help our customers achieve innovative and cost-efficient solutions.





From initial concept to serial production

Concept development

We develop different cost-efficient fiber composite solutions for your application, specifically tailored to your requirements.

Product design

Our experienced design team creates detailed CAD models for you.

Process simulation

On the basis of your fiber composite production process, we determine the technological boundary conditions, such as material and process parameters.

Structural analysis

We analyze and optimize your composite structure in the light of structural requirements such as stiffness and strength.

Virtual prototyping

We optimize your production process with the aim of achieving a "first time right" prototype.

Prototyping

A floor space of over 1500 m² is available. Your prototype is produced on state-of-the-art machines.

Product testing

We test the finished components in our in-house composites laboratory. The results are fed straight back into the product development process.

Factory simulation

Already during product development, we analyze and visualize the production process and therefore can plan large-scale production and material flows.

Smart Solutions

Be it materials, components or production processes, we focus our thinking and actions on the customer and keep an eye on the big picture. Our solutions already anticipate the future today.

The following examples show a selection of our unique product range.

Mobility

- Lightweight components and structural parts based on fiber-reinforced composites for automotive and aerospace manufacture
- Graphite anode material for lithium-ion batteries in electric vehicles
- Carbon-ceramic brake disks for sports cars and luxury sedans

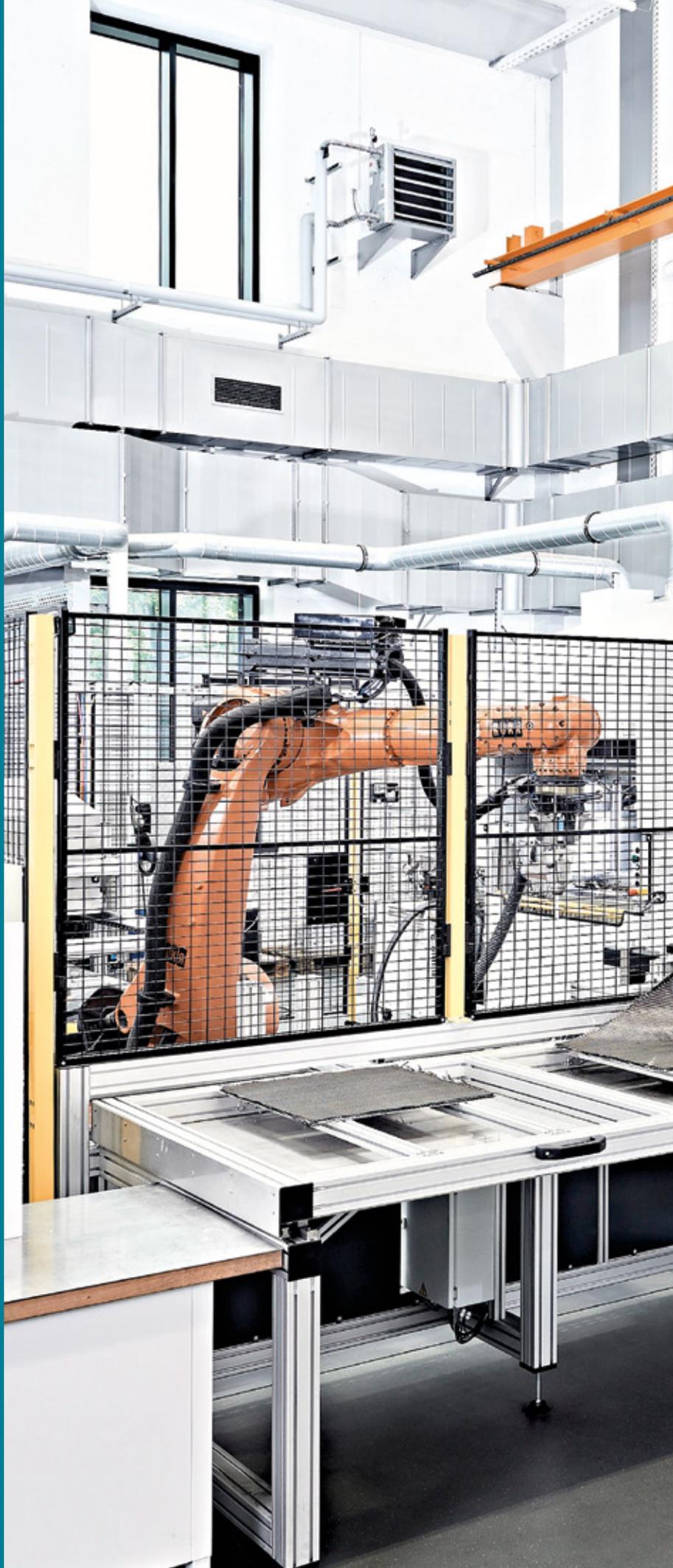
Energy

- High-temperature solutions based on specialty graphites and fiber materials for the photovoltaic industry
- Carbon fiber materials for rotor blades
- Gas diffusion layers for fuel cells
- Systems for more efficient heat exchange and heat recovery
- Carbon fibers for pressurized gas containers

Digitization

- Carbon, graphite, and CFC components for polysilicon and monocrystal pulling in the semiconductor industry
- High precision, coated graphite carriers for the production of LEDs

→ Wet pressing process for CFRP component production in the Lightweight and Application Center



SGL Carbon

We are leaders in the development and manufacture of products based on carbon, graphite, carbon fibers, and fiber-reinforced composites. In partnership with our customers, we develop intelligent, trendsetting, and sustainable solutions that deliver a clear benefit.

With our in-depth material, engineering, and application know-how, we make a substantial contribution to the major future topics mobility, energy, and digitization.



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