sgl carbon

# The Simplifiers

## Our pre-impregnated materials made from carbon, glass, and aramid fibers

SIGRAPREG®

Composites – Fibers & Materials


# SIGRAPREG® snap-cure
# Simple. Fast. Cost-efficient.

SIGRAPREG from SGL Carbon is the brand name for state-of-the-art pre-impregnated reinforcing materials that can be combined with different resin systems, such as our fast-curing snap-cure epoxy resin system we developed in-house. Curing times of between 1.5 and 3 minutes and the possibility of using simple isothermal processes permit very short cycles in automated large-volume production of composite components. In this way, long production runs – like the ones required in the automotive industry – can be produced very simply, rapidly and cost-efficiently in extremely high quality. Smart solutions from SGL Carbon – real simplifiers.


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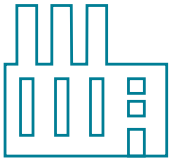
# Our pre-impregnated materials made from carbon, glass, and aramid fibers

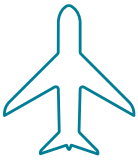
**Whether based on woven fabrics, non-crimp textiles, non-wovens, or TowPregs – our pre-impregnated materials are proving highly successful in a wide range of applications across numerous industries. With our top-quality products and outstanding expertise in all processing steps, we are able to offer smart solutions with genuine added value for our customers‘ products and processes.**



| Market segments of our Business Unit Composites – Fibers & Materials | Automotive | Industrial Applications |
|---|---|---|
| Typical applications | • Structural components<br>• Design components<br>• Chassis components<br>• Drive train | • Medical technology<br>• Robotics and automation technology<br>• Measuring technology and optics<br>• Machinery manufacture<br>• Sports & leisure<br>• Antiballistic technology<br>• Marine industry |
| Typical products | • A, B, C pillar reinforcement<br>• Roof modules<br>• Trunk lids<br>• Leaf springs<br>• Drive shafts | • X-ray patient supports<br>• Robot arms<br>• Sensor tubes<br>• Lifting beams<br>• Add-on parts for motor sport<br>• Safety helmets<br>• Boat hulls |
| Materials used from SGL Carbon | • SIGRAPREG® unidirectional prepregs<br>• SIGRAPREG® multiaxial fabric prepregs<br>• SIGRAPREG® woven fabric prepregs (surface quality)<br>• SIGRAPREG® non-woven prepregs<br>• SIGRAPREG® TowPregs | • SIGRAPREG® unidirectional prepregs<br>• SIGRAPREG® multiaxial fabric prepregs<br>• SIGRAPREG® woven fabric prepregs<br>• SIGRAPREG® non-woven prepregs<br>• SIGRAPREG® TowPregs<br>• SIGRAPREG® adhesive films |

**Simplifying component production by pre-impregnation**
Our pre-impregnated materials are ideally suitable for the production of stiff, strong, ultra-lightweight fiber composites as are often required for lightweight parts, high-tech applications, and components subject to extreme stress. From the automotive industry and industrial applications to aerospace and the energy sector, our prepregs have become established worldwide as the preferred material for challenging applications.

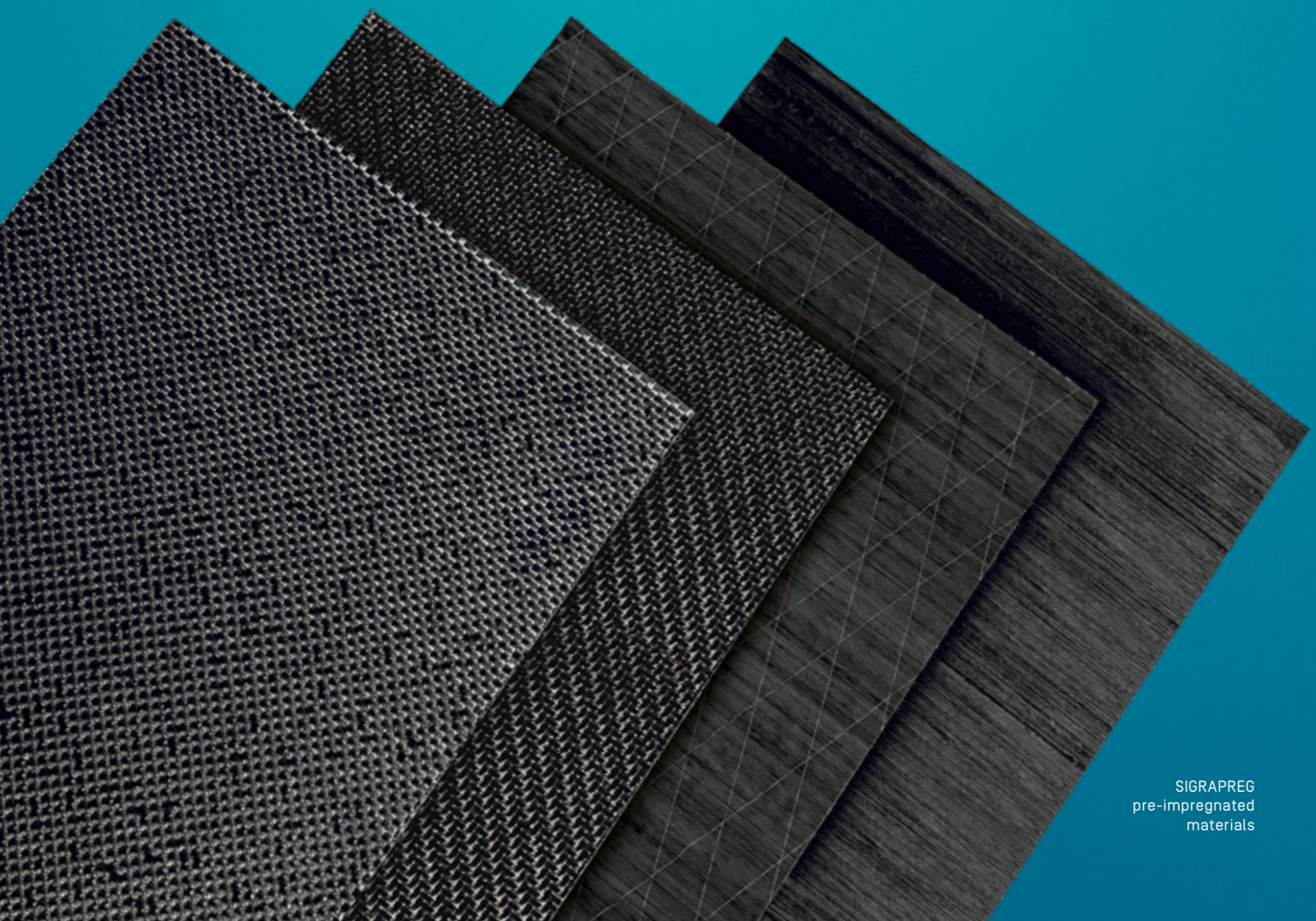
In addition to their outstanding mechanical properties, our prepregs make an important contribution to efficient production processes. This is because they save our customers having to carry out the costly processing step of impregnation, which is so critical to quality. This makes component production far simpler and completely dispenses with the need for mixing, storage, and disposal of resin components.



| Aerospace | Energy |
|---|---|
| • Primary and secondary structural components<br>• Interior components | • Renewable energies |
| • Payload fairings<br>• Tanks<br>• Partition walls<br>• Aircraft seats<br>• UAV structural components<br>• Floor panels<br>• Rotor blades | • Spar caps for wind turbines<br>• Pipes and risers for oil and gas<br>• Electric cables<br>• Gas storage tanks |
| • SIGRAPREG® unidirectional prepregs<br>• SIGRAPREG® woven fabric prepregs<br>• SIGRAPREG® TowPregs | • SIGRAPREG® unidirectional prepregs<br>• SIGRAPREG® woven fabric prepregs<br>• SIGRAPREG® TowPregs |

# Simple, flexible: our material toolboxes

For fiber-reinforced thermosets used in automotive and aerospace applications, we have developed material toolboxes consisting of pre-impregnated semi-finished products. These toolboxes contain a wide variety of reinforcing materials all based on the same resin system, which is tailored to the specific application. In this way, time and money that would otherwise be spent on qualification processes, tests, and process optimization is reduced. In addition, the various materials have guaranteed compatibility with each other and so can be flexibly combined and processed – for maximum design freedom.



SIGRAPREG
pre-impregnated
materials

# A complete portfolio: prepregs based on woven fabrics, non-crimp textiles, and non-wovens, adhesive films and TowPregs

We supply the whole range of textile reinforcing materials produced from carbon, glass, and aramid fibers and impregnated with various resin systems – from prepregs based on woven fabrics, non-crimp textiles, and non-woven fabrics to adhesive films and TowPregs.

Our pre-impregnated materials have outstanding, reproducible properties and can be tailored perfectly to individual requirements. We use state-of-the-art resin systems that we formulate ourselves in-house. In addition, we can employ various production and processing methods. Prepregs from SGL are ideally suitable for efficient component production and all currently used processes:

**Typical processing methods**
- Hand lay-up
- Automated placement processes
- Winding processes

**Typical curing processes**
- Autoclaving
- Pressing
- Oven (vacuum bag)

## SIGRAPREG – the basis for components with key advantages:

- Excellent mechanical properties
- Low density
- Low thermal expansion
- Good electrical conductivity
- High fatigue resistance
- High corrosion resistance

### Prepreg manufacturing process

# High-quality resin systems developed in-house

SIGRAPREG prepregs are the result of our consistently customer-focused product development. They unite maximum performance with minimum weight and can be optimally adapted to the requirements of different end uses. We combine high-quality resin systems that we formulate ourselves in-house with state-of-the-art reinforcing materials. Our range comprises a wide variety of resin systems with different glass transition temperatures, curing temperatures and times, viscosity, tack, and storage stability.

↑ Resin application for impregnation

## Nomenclature

**SIGRAPREG C W95-PL1/1-E331/48%**

1 | 2 | 3 | 4 | 5 | 6 | 7

| | | |
|---|---|---|
| 1 | Brand name | SIGRAPREG |
| 2 | Material | C = carbon, G = glass, A = aramid, H = hybrid, F = film |
| 3 | Type | W = woven fabric, U = unidirectional, B = biaxial, T = triaxial, Q = quadriaxial, N = non-woven |
| 4 | Fiber areal weight | in g/m² |
| 5 | Weave, fixation fiber orientation | woven fabric: PL 1/1 = plain, TW 2/2 = twill 2/2, non-woven: IS = isotropic<br>multiaxial: 0 = 0°, 45 = -45°/+45°<br>NF = not fixed, SO = scrim one-sided, SD = scrim double-sided, ST = stitched |
| 6 | Resin type | Exxx = epoxy, Pxxx = phenolic |
| 7 | Resin mass content | in % |

## Individual resin systems for a wide variety of requirements

| Resin system | Resin type | Tg [°C] | Curing temperature [°C] | Storage life at 20 °C [days] | Storage life at -18 °C [months] | Tack[1] | Impact-modified |
|---|---|---|---|---|---|---|---|
| E500 \| E501 \| E502 \| E503 | epoxy | 110 | 80 – 160 | 70 | 12 | L/M/H | yes |
| E300 \| E301 | epoxy | 120 | 70 – 120 | 21 | 4 | L/M/H | yes |
| E400 \| E402 | epoxy | 120 | 80 – 140 | 40 | 12 | L | no |
| E310 \| E311 | epoxy | 120 | 80 – 160 | 14 | 6 | L/M/H | yes |
| E320 \| E321 \| E322 \| E323 | epoxy | 120 | 90 – 140 | 90 | 12 | M | yes |
| E450 | transparent epoxy | 120 | 120 – 160 | 28 | 6 | M | no |
| E700 | epoxy | 120 | 140 – 160 | 14 | 12 | M | yes |
| E302 | epoxy | 130 | 70 – 140 | 14 | 12 | L/M/H | no |
| E340 | epoxy | 140 | 100 – 150 | 90 | 12 | L/M | no |
| E330 | epoxy | 145 | 80 – 160 | 28 | 12 | L/M/H | yes |
| E420 | snap-cure epoxy | 150 | 120 – 170 | 28 | 12 | M | no |
| E800 | epoxy | 220 | 80 – 200 | 14 | 12 | L/M/H | no |
| P320 \| P321 \| P322 | phenolic | > 200 | 100 – 180 | 180 | 12 | M/H | no |
| P360 | phenolic | – | 120 – 160 | 7 | 6 | L/M | – |
| P500 | phenolic | – | 150 – 170 | 28 | 12 | L/M/H | yes |

Other resin systems are available on request. [1] L = low, M = medium, H = high

# Prepregs based on woven, non-crimp, and non-woven structures

Our pre-impregnated semi-finished products are based on unidirectional, multiaxial, woven, and non-woven fabric structures. We produce unidirectional and multiaxial prepregs with different areal weights and a wide variety of reinforcing fibers. They can be produced with our own fabric structures as well as by direct processing of the reinforcing fibers without additional fixation. The woven fabrics are made in our own weaving facility from 1k, 3k, 6k, 12k or 24k carbon fiber rovings. In hybrid woven fabrics, we also process glass and aramid fibers. For our non-woven prepregs, we use 50k heavy tows with isotropic fiber distribution.

↑ SIGRAPREG carbon fiber woven fabric prepreg

## Material data of our SIGRAPREG® prepregs

| Material type | Weave/orientation | Areal weight [dry] [g/m²] | Resin type | Resin mass content [%] |
|---|---|---|---|---|
| **Unidirectional prepregs** | | | | |
| C U200-0/NF-E310/30% | unidirectional | 200 | epoxy | 30 |
| C U255-0/NF-E322/37% | unidirectional | 255 | epoxy | 37 |
| C U300-0/NF-E420/38% | unidirectional | 300 | snap-cure epoxy | 38 |
| C U100-0/SO-E501/40% | unidirectional | 100 | epoxy | 40 |
| C U150-0/SO-P360/43% | unidirectional | 150 | phenolic | 43 |
| C U450-0/SD-E501/36% | unidirectional | 450 | epoxy | 36 |
| C U600-0/SD-E501/33% | unidirectional | 600 | epoxy | 33 |
| **Woven fabric prepregs** | | | | |
| C W95-PL1/1-E323/48% | plain | 95 | epoxy | 48 |
| C W160-PL1/1-E323/50% | plain | 160 | epoxy | 50 |
| C W200-TW2/2-E311/48% | twill 2/2 | 200 | epoxy | 48 |
| C W200-TW2/2-E501/48% | twill 2/2 | 200 | epoxy | 48 |
| C W200-PL1/1-E323/42% | plain | 200 | epoxy | 42 |
| C W200-TW2/2-E420/40% | twill 2/2 | 200 | snap-cure epoxy | 40 |
| C W245-TW2/2-E503/44% | twill 2/2 | 245 | epoxy | 44 |
| C W245-TW2/2-E323/45% | twill 2/2 | 245 | epoxy | 45 |
| C W245-TW2/2/SQ-E450/43% | twill 2/2 | 245 | transparent epoxy | 43 |
| C W305-PL1/1-E331/41% | plain | 305 | epoxy | 41 |
| C W410-TW2/2-E501/42% | twill 2/2 | 410 | epoxy | 42 |
| C W665-TW2/2-E323/40% | twill 2/2 | 665 | epoxy | 40 |
| **Multiaxial fabric prepregs** | | | | |
| C B160-45/SO-E501/47% | biaxial | 160 | epoxy | 47 |
| C B450-45/SO-E501/38% | biaxial | 450 | epoxy | 38 |
| C B300-45/ST-E331/42% | biaxial | 300 | epoxy | 42 |
| C B610-45/ST-E320/40% | biaxial | 610 | epoxy | 40 |
| **Non-woven prepregs** | | | | |
| C N450-IS/NF-E501/65% | isotropic | 450 | epoxy | 65 |
| C N450-IS/NF-E420/65% | isotropic | 450 | snap-cure epoxy | 65 |

Other types available on request.

# TowPregs based on filament yarns

↑ SIGRAPREG TowPreg

SIGRAPREG TowPregs are pre-impregnated fiber bundles made from carbon and glass fiber heavy tows. Besides the fiber type and resin system, it is also possible to individually adjust resin content and TowPreg width and produce to very high consistency. In this way, together with our customers, we can develop the optimum material, even for special applications.

Our TowPregs help achieve better results in challenging processes. They not only impart excellent mechanical properties to components, they also have outstanding processing properties because of their constant width and optimized tack. So, for example, they permit uniform winding to the highest precision and also perform impressively in challenging fiber placement processes thanks to their easy processability.

TowPregs from SGL enable components to be designed in accordance with the expected load paths and produced virtually waste-free. Pre-impregnation and the deliberate avoidance of release films or papers save our customers time and money, while offering additional benefits in terms of environmental protection and safety.

**Typical applications**

- Wound structures, e.g. tanks
- Marine masts
- Automotive components
- Aircraft components
- Sports articles
- Leaf springs

## Nomenclature

**SIGRAPREG C TP50/13-4.4/255-E420/38%**

1 | 2 | 3 | 4 | 5 | 6 | 7 | 8

| | | |
|---|---|---|
| 1 | Brand name | SIGRAPREG |
| 2 | Material | C = carbon, G = glass |
| 3 | Type | TP = TowPreg |
| 4 | Number of filaments | 24 = 24000 filaments, 50 = 50000 filaments |
| 5 | Width | mm (rounded) |
| 6 | Mechanical properties of the fiber | Tensile strength/tensile modulus (GPa) |
| 7 | Resin type | Exxx = epoxy, Pxxx = phenolic |
| 8 | Resin mass content | in % |

## Material data of our SIGRAPREG® TowPregs

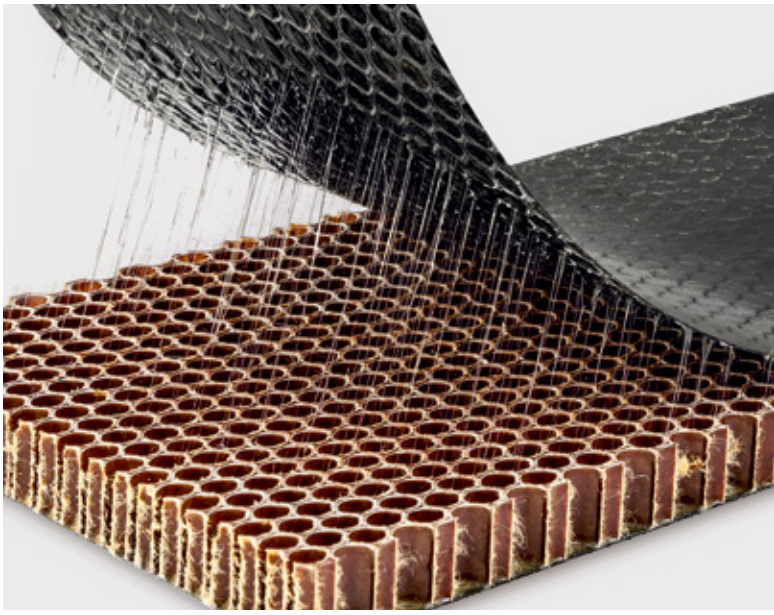
| Material type | Fineness of yarn (tex) | TowPreg width (mm) | Resin type | Resin mass content (%) |
|---|---|---|---|---|
| C TP24/6-5.0/270-E910/35% | 1600 | 6.4 | epoxy | 35 |
| C TP50/13-4.4/255-E420/38% | 3450 | 12.7 | snap-cure epoxy | 38 |
| G TP4/6-2.5/81-E910/30% | 2400 | 6.4 | epoxy | 30 |

Other types available on request.

# Adhesive films based on our resin systems

Our SIGRAPREG adhesive films are thin resin films, e.g. made from epoxy or phenolic resin systems. They ensure good adhesion between our prepregs and various core materials such as honeycombs, metals, and foams.

The adhesive film formulations are specially matched to our prepreg resin systems to ensure optimum compatibility. In this way, sandwich and hybrid materials for a wide variety of applications, for example in the aerospace and automotive sectors, can be produced even more efficiently.



↑ SIGRAPREG adhesive film for bonding prepregs to honeycombs

## Material data of our SIGRAPREG® adhesive films

| Material type | Tg [°C] | Curing temperature [°C] | Areal weight [g/m²] | Resin type | Resin mass content [%] | Carrier material | Notes |
|---|---|---|---|---|---|---|---|
| F 250-E600/100% | 85 | 140 – 190 | 250 | epoxy | 100 | | optimized crash behavior |
| F 250-E610/100% | 100 | 80 – 120 | 250 | epoxy | 100 | | specially recommended for marine applications |
| F 250-E620/100% | 120 | 120 – 160 | 250 | epoxy | 100 | | |
| F 250-E640/100% | 140 | 120 – 160 | 250 | epoxy | 100 | | |
| F 250-E660/100% | 160 | 140 – 180 | 250 | epoxy | 100 | | |
| F 50-E670/100% | 140 | 140 – 160 | 50 | epoxy | 100 | | specially recommended for aerospace applications |
| H N30-E310/77% | 120 | 80 – 160 | 130 | epoxy | 77 | polyester non-woven | |
| G N30-P360/80% | | 120 – 150 | 150 | phenolic | 80 | glass non-woven | |
| H N30-P500/57% | | 140 – 160 | 70 | phenolic | 57 | polyester non-woven | |
| G W48-PL1/1-C300/78% | 180 | 160 – 200 | 218 | cyanate ester | 78 | glass non-woven | |

Other types available on request.

# Successful together

What matters to us as solution providers is added value for our customers. So we not only offer first-class materials but also the opportunity to develop components and systems together.

With a broad range of pre-impregnated semi-finished products, we supply the perfect basis for efficient, cost-optimized serial production of fiber composites. In addition, we produce material systems individually tailored to the special processes and products of our customers.

## Efficiency through automation

**Lightweight construction with SIGRAPREG TowPregs**
Exceptional efficiency starts with the right material. For example, with SIGRAPREG TowPregs based on our SIGRAFIL 50k carbon fibers. With their outstanding properties, our 50k heavy tows lay the foundation for cost-effective production of fiber composite components.

In combination with the right resin system, our TowPregs create a high-performance material that makes lightweight construction simple and efficient. For example, our 50k TowPreg with snap-cure resin E420 was specially developed and optimized for automated placement processes. Unlike in conventional processing of flat semi-finished products, it is possible with this material to produce load-optimized laminates and preforms in near-net shape, which considerably improves material utilization. Downstream curing in simple processes taking just a few minutes is a further advance that makes cost-efficient, rapid production of our customers' components as easy as possible.

# 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

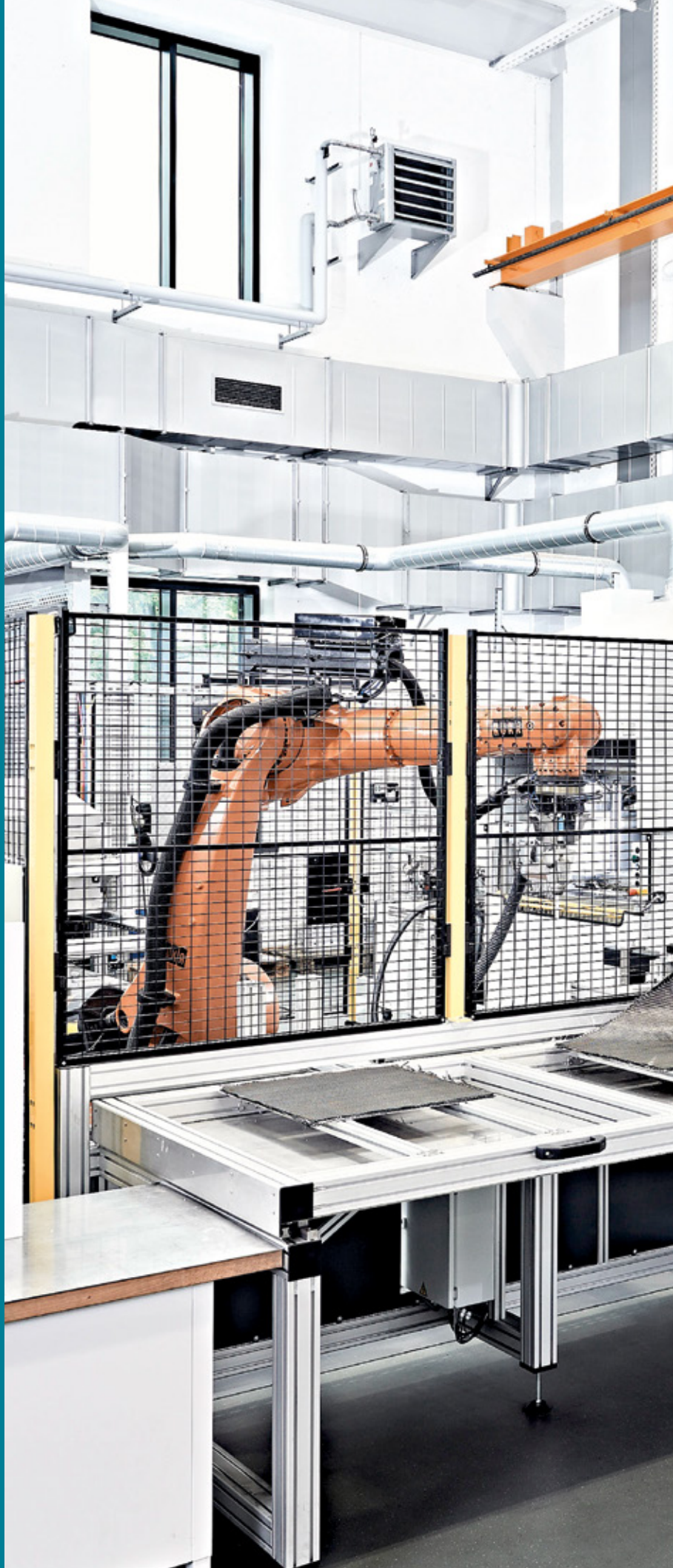
## Energy

- 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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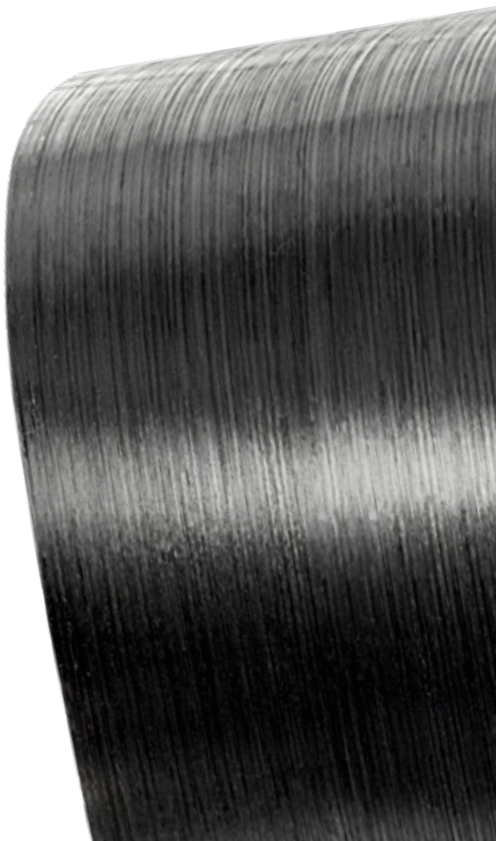

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