

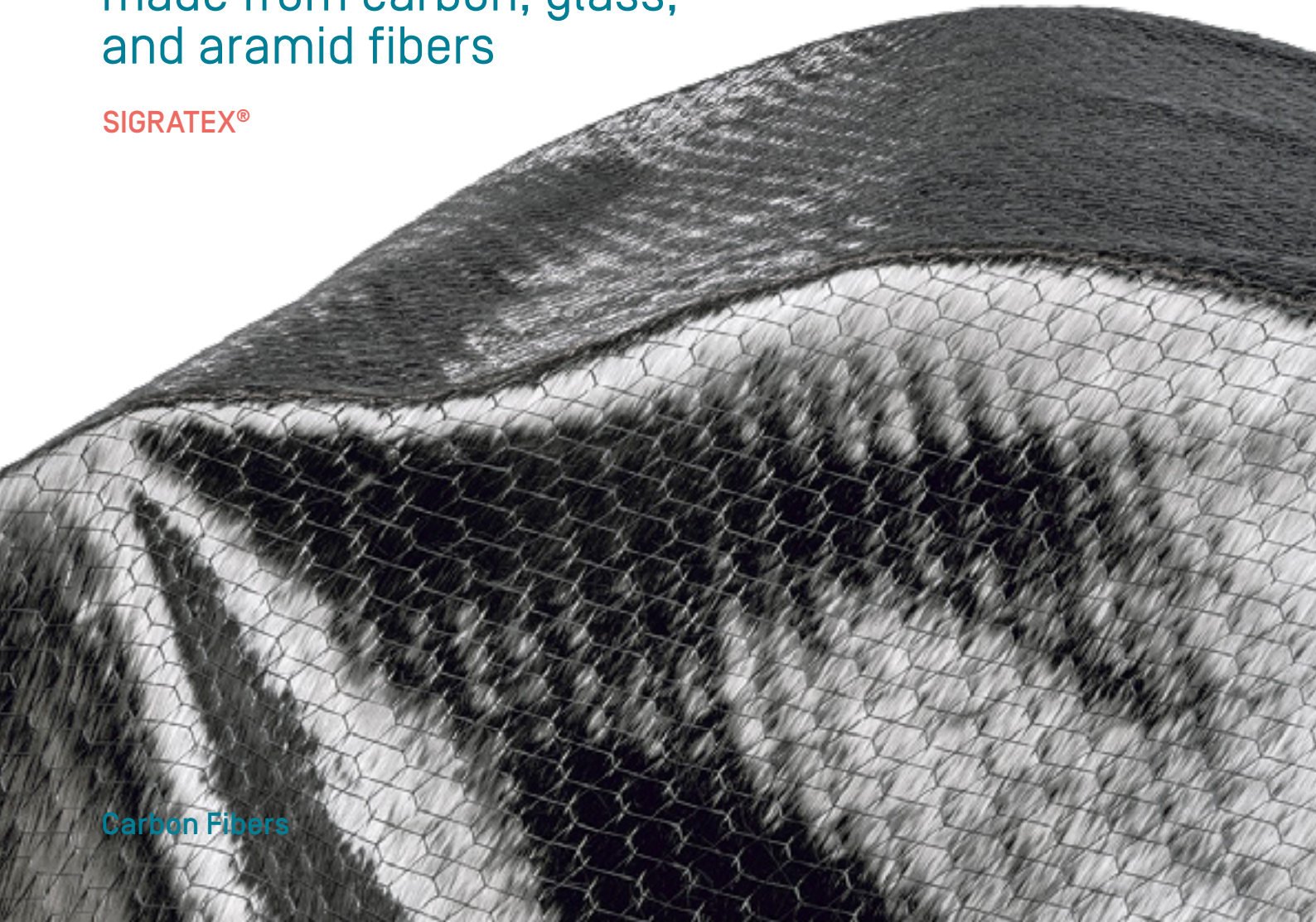


# The Drapables

Our textile materials  
made from carbon, glass,  
and aramid fibers

**SIGRATEX®**

Carbon Fibers



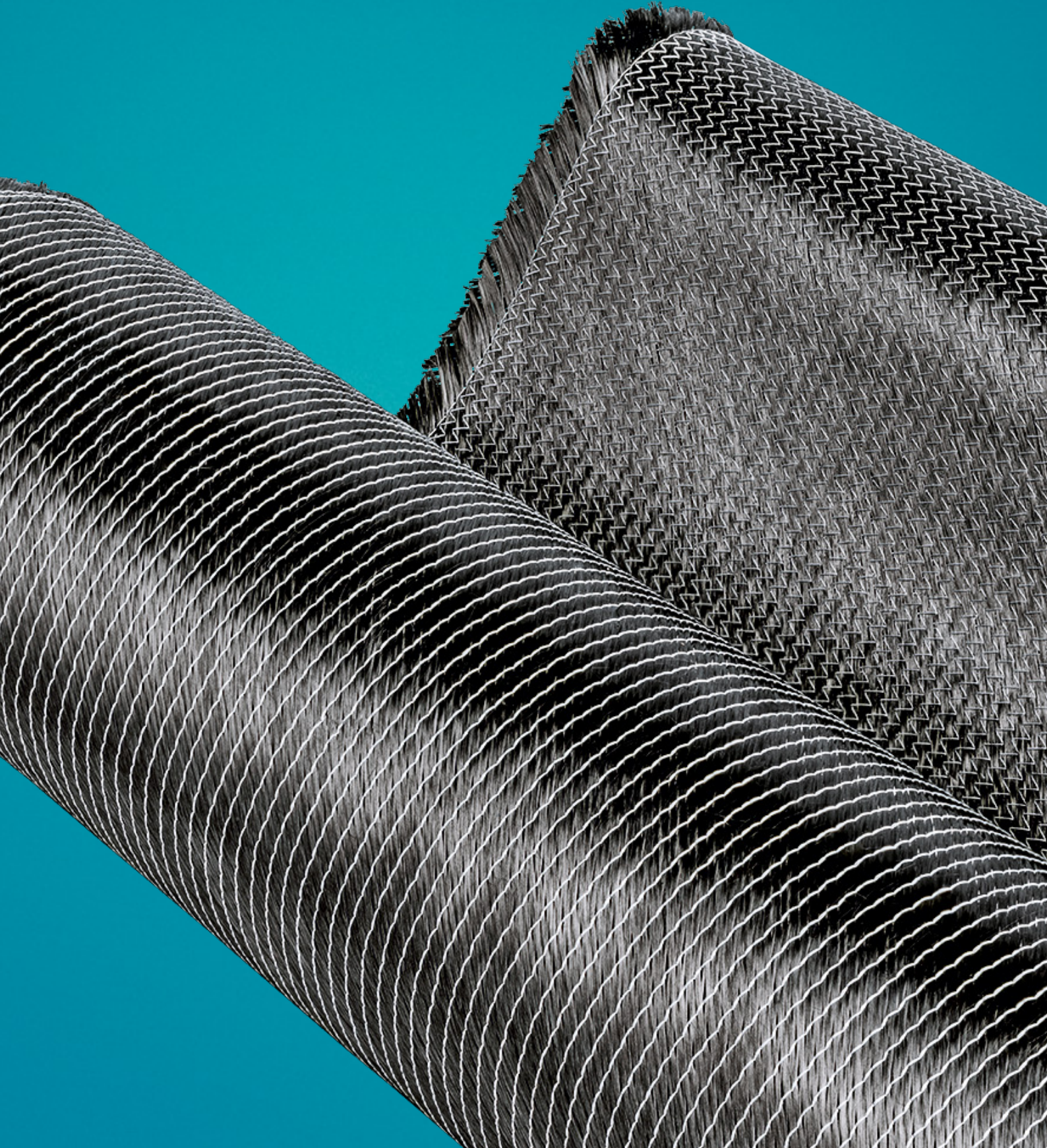
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## **SIGRATEX<sup>®</sup> biaxial carbon fiber fabrics** **Tailored textile solution**

They have two layers, two orientations, one plane – and numerous advantages for our customers: our biaxially fixed carbon fiber fabrics with  $\pm 45^\circ$  orientation. Due to their stretched fibers, non-crimp fabrics have much better mechanical properties than woven fabrics. Our biaxial carbon fiber fabrics are made from high-quality carbon fiber tows with 50 000 filaments that we produce ourselves. Biaxial fabrics from SGL are easy to handle, easy to infuse with resin – and, above all, have very good drapability. Even for challenging shapes. Smart solutions from SGL Carbon – the real drapables.



# Our textile materials made from carbon, glass, and aramid fibers

Textile materials from SGL make composites extremely light, stiff, and strong. They have good drapability, are easy to process, and are compatible with different resin systems. Our portfolio includes a broad spectrum of non-crimp textiles, woven fabrics, woven tapes, stacks, and non-wovens. We can supply customer-tailored variants for specific requirements.



## Market segments of our Business Unit Carbon Fibers

### Typical applications

### Automotive

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

### Industrial Applications

- Medical technology
- Robotics and automation technology
- Measuring technology and optics
- Machinery manufacture
- Sports & leisure
- Antiballistic technology
- Marine industry

### Typical products

- A,B,C pillars and sills
- Roof modules
- Trunk lids
- Leaf springs
- Battery casings
- Interior trim

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

### Materials used from SGL Carbon

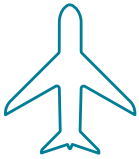
- SIGRATEx® unidirectional fabrics
- SIGRATEx® multiaxial fabrics
- SIGRATEx® woven fabrics [surface quality]
- SIGRATEx® woven fabrics
- SIGRATEx® non-wovens
- SIGRATEx® stacks

- SIGRATEx® unidirectional fabrics
- SIGRATEx® multiaxial fabrics
- SIGRATEx® woven fabrics
- SIGRATEx® woven tapes
- SIGRATEx® non-wovens
- SIGRATEx® stacks

### Solutions for high-quality components

Textile materials from SGL form the ideal basis for the production of high-quality fiber-reinforced plastics. They are suitable for a wide variety of processing technologies and open up new possibilities in the serial production of fiber-reinforced components. Particularly in high-tech applications, where very high strength and stiffness coupled with minimal weight are required,

SIGRATEX products are used worldwide – for example in the automotive industry, the aerospace industry, the energy sector, and other industrial applications. As solution providers, we bring our comprehensive expertise across all processing steps to bear in planning and implementing customer projects.



#### Aerospace

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- Primary and secondary structural components
- Interior components

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- Fairings
  - Tanks
  - Aircraft seats
  - Wing components
  - Mold making

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- SIGRATEX® unidirectional fabrics
  - SIGRATEX® woven fabrics
  - SIGRATEX® woven tapes
  - SIGRATEX® stacks
- 



#### Energy

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- Renewable energies

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- Spar caps for wind turbines
  - Pipes and risers for oil and gas
  - Electric cables
  - Gas storage tanks

- 
- SIGRATEX® unidirectional fabrics
  - SIGRATEX® multiaxial fabrics
  - SIGRATEX® woven fabrics
  - SIGRATEX® stacks
-

# Material from which the strongest components are made

SIGRATEX products from SGL are used mainly as reinforcing materials for the production of components subject to high service stress. For this purpose, we supply a comprehensive portfolio of high-quality non-crimp textiles, woven fabrics, woven tapes, stacks and non-wovens based on carbon, glass, and aramid fibers. With their outstanding properties, such as good drapability, they form the ideal basis for lightweight, high-strength components.

# Materials that make everything possible

The many possible options for making high-quality composites from our products are matched by the wide range of processes our customers can use:

## Suitable customer processes

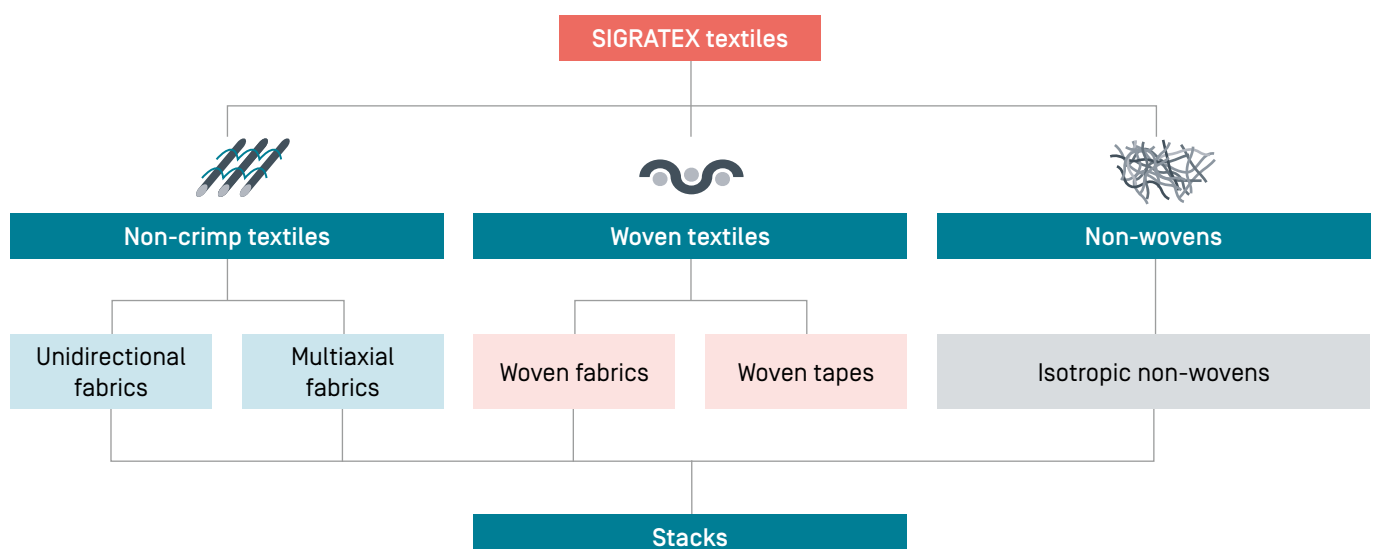
- Prepreg production
- Wet lamination
- Infusion
- Wet pressing
- Resin Transfer Molding (RTM)

## Result of decades-long experience

All our high-performance textiles are the result of decades-long experience in material development plus comprehensive application know-how. SIGRATEx products offer important advantages:

- **Good drapability**
- **Very good infusion properties**
- **Excellent mechanical properties**
- **Outstanding possibilities for use in challenging visible applications**

## Overview of our portfolio



# SIGRATEX<sup>®</sup>

## non-crimp textiles

SIGRATEX non-crimp fabrics are high-quality textile reinforcing materials that we produce for our customers from our SIGRAFIL continuous carbon fiber tow containing 50 000 filaments (50k) or from glass fibers. Our 50k carbon fibers are produced in our own plants in Europe and North America.



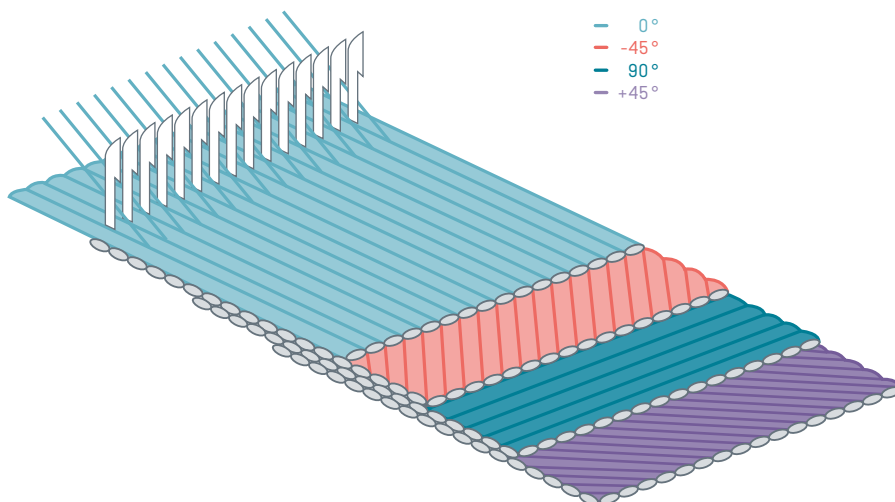
## Best mechanical properties

Non-crimp textiles consist of one or more layers (plies) of fibers placed in the same or different orientations – so-called unidirectional or multi-axial fabrics. The fibers are stitched together with knitting threads. Unlike with woven fabrics, the fibers in non-crimp textiles are stretched out straight and strategically placed in line with the expected stresses. In this way, additional structural elongation is avoided, which gives the fabrics better mechanical properties for use as textile reinforcing materials. We offer our fabrics with different stitching types, such as pillar, offset pillar, tricot, double tricot or hexagonal stitching.

### Non-crimp textiles impress in numerous applications

- Good drapability for easy adaptation to different shapes
- Optimization of automated stacking processes permits flexible layer structure
- Excellent resin infiltration properties for rapid injection processes

### Possible layer structures



### Reliability guaranteed with proven non-crimp fabrics from SGL Carbon

- Consistently high quality through online monitoring
- Complete traceability in the value chain
- Secure supply chain through use of our own carbon fibers
- Application support (material selection, design, engineering, component processes)
- Successful use in large-scale automotive production

# SIGRATEX® unidirectional fabrics

Our SIGRATEX unidirectional fabrics consist of special 12k up to 50k carbon fibers and glass fibers. They are stitched with a fine polyester yarn or fixed with a very lightweight single- or double-sided scrim. With medium to high filament counts, low areal weights can be achieved with corresponding cost advantages. This makes our unidirectional SIGRATEX fabrics suitable for many different applications. Their variable width, up to 3022 mm, additionally opens up the spectrum of use.



↑ SIGRATEX stitched unidirectional fabric made from carbon fibers

## Material data of our SIGRATEX® stitched unidirectional carbon fiber fabrics

Material type	Fiber orientation	Weight of carbon fiber layer [g/m <sup>2</sup> ]	Weight of glass yarn [g/m <sup>2</sup> ]	Weight of polyester yarn [g/m <sup>2</sup> ]	Weight of binder [g/m <sup>2</sup> ]	Total areal weight [g/m <sup>2</sup> ]	Binder type
C U170-0/ST-E214/10g	0°	154	10	7	10	181	E214
C U170-45/ST-E214/10g	+45°	154	7	8	10	179	E214
C U170-45/ST-E214/10g	-45°	154	7	8	10	179	E214
C U170-90/ST-E214/10g	90°	154	6	8	10	178	E214
C U320-45/ST-E214/10g	+45°	307	7	8	10	332	E214
C U320-45/ST-E214/10g	-45°	307	7	8	10	332	E214
C U320-90/ST-E214/10g	90°	307	6	8	10	331	E214
C U330-0/ST-E214/10g	0°	307	14	7	10	338	E214
C U480-0/ST-E214/10g	0°	462	13	7	10	492	E214
C U640-0/ST-E214/10g	0°	614	14	8	10	646	E214

Other types and widths available on request. Fabric types can be produced with/without binder.

## Material data of our SIGRATEX® stitched unidirectional glass fiber fabrics

Material type	Fiber orientation	Weight of glass fiber layer [g/m <sup>2</sup> ]	Weight of glass yarn [g/m <sup>2</sup> ]	Weight of polyester yarn [g/m <sup>2</sup> ]	Weight of binder [g/m <sup>2</sup> ]	Total areal weight [g/m <sup>2</sup> ]	Binder type
G U240-45/ST-E214/10g	+45°	226	8	9	10	253	E214
G U240-45/ST-E214/10g	-45°	226	8	9	10	253	E214
G U470-45/ST-E214/10g	+45°	451	8	9	10	478	E214
G U470-45/ST-E214/10g	-45°	451	8	9	10	478	E214
G U1180-0/ST-E215/10g	0°	1134	27	17	10	1188	E215

Other types and widths available on request. Fabric types can be produced with/without binder.

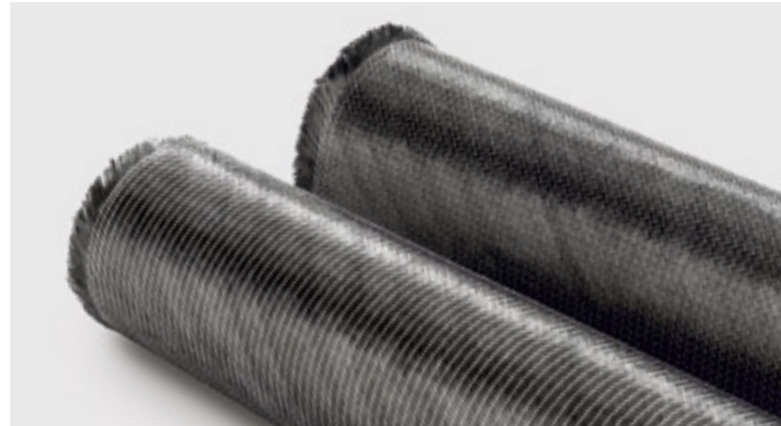
## Material data of our SIGRATEX® fixed unidirectional carbon fiber fabrics

Material type	Fiber orientation	Areal weight [g/m <sup>2</sup> ]	Fixation
C U80-0/S0	0°	80	scrim one-sided
C U100-0/S0	0°	100	scrim one-sided
C U125-0/S0	0°	125	scrim one-sided
C U150-0/S0	0°	150	scrim one-sided
C U200-0/S0	0°	200	scrim one-sided
C U250-0/S0	0°	250	scrim one-sided
C U300-0/SD	0°	300	scrim double-sided
C U450-0/S0	0°	450	scrim double-sided
C U600-0/SD	0°	600	scrim double-sided

Other types and widths available on request.

# SIGRATEX® multiaxial fabrics

SIGRATEX multiaxial fabrics are textile complexes with targeted fiber orientation that enable many different, efficient structures to be produced. They are stitched with a fine polyester yarn. SIGRATEX multiaxial fabrics offer greater stability with reduced material use. They also allow better optimization of component design, while cutting production costs at the same time.



↑ SIGRATEX stitched biaxial fabric made from carbon fibers

## Material data of our SIGRATEX® stitched biaxial carbon fiber fabrics

Material type	Fiber orientation	Weight of carbon fiber layer [g/m <sup>2</sup> ]	Weight of polyester yarn [g/m <sup>2</sup> ]	Weight of binder [g/m <sup>2</sup> ]	Total areal weight [g/m <sup>2</sup> ]	Binder type
C B260-45/ST-E214/10g	+/- 45°	45° layer: 127 45° layer: 127	5	10	269	E214
C B310-45/ST-E214/5g	+/- or +/- 45°	45° layer: 154 45° layer: 154	5	5	318	E214
C B410-45/ST-E214/10g	-/+ or +/- 45°	45° layer: 200 45° layer: 200	5	5	415	E214
C B610-45/ST-E214/10g	+/- or +/- 45°	45° layer: 300 45° layer: 300	5	10	615	E214
C B310-090/ST	90°/0°	90° layer: 154 0° layer: 154	6	0	314	E214
C B410-090/ST	90°/0°	90° layer: 200 0° layer: 200	6	0	406	E214
C B610-090/ST	90°/0°	90° layer: 300 0° layer: 300	6	0	606	E214

Other types and widths available on request. Fabric types can be produced with/without binder.

## Material data of our SIGRATEX® stitched biaxial glass fiber fabrics

Material type	Fiber orientation	Weight of glass fiber layer [g/m <sup>2</sup> ]	Weight of polyester yarn [g/m <sup>2</sup> ]	Weight of binder [g/m <sup>2</sup> ]	Total areal weight [g/m <sup>2</sup> ]	Binder type
G B610-45/ST-E214/10g	+/- or +/- 45°	45° layer: 300 45° layer: 300	10	10	620	E214

Other types and widths available on request. Fabric types can be produced with/without binder.

## Nomenclature



### SIGRATEX C U330-0/ST-E214/10g

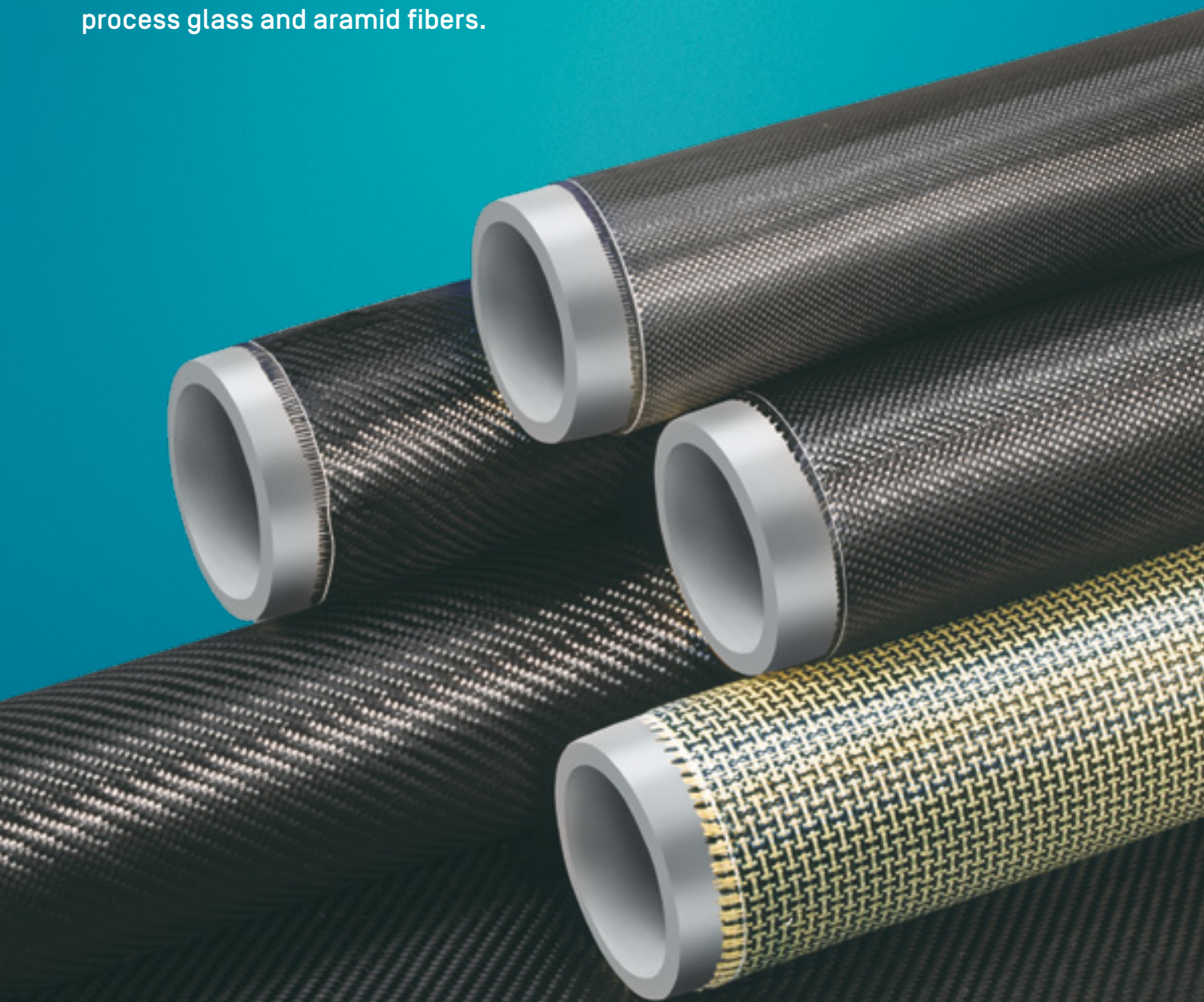
1 2 3 4 5 6 7

1 Brand name	SIGRATEX
2 Material	C = carbon, G = glass, A = aramid, H = hybrid
3 Type	W = woven fabric, U = unidirectional, B = biaxial, T = triaxial, Q = quadriaxial, N = non-woven
4 Areal weight	in g/m <sup>2</sup>
5 Weave	woven fabrics/tapes: PL 1/1 = plain, TW 2/2 = twill 2/2, TW 4/4 = twill 4/4; HS 1/7 = satin 1/7
Fiber orientation	multiaxial: 0 = 0°, 090 = 0°/90°, 45 = -45°/+45°, 045 = 0°/-45°/+45°, 04590 = 0°/-45°/90°/+45° non-woven: IS = isotropic
6 Fixation	S0 = scrim one-sided, SD = scrim double-sided, ST = stitched, NF = not fixed
7 Additional features	binder/grammage, tracer threads in non-wovens

# SIGRATEX<sup>®</sup>

## woven fabrics

In our weaving facility, we produce a wide range of SIGRATEX woven fabrics, tapes, and non-wovens. We use 1k, 3k, 6k, 12k, and 24k carbon fiber tows as the material basis. In hybrid woven fabrics, we also process glass and aramid fibers.



## SIGRATEX<sup>®</sup> woven fabrics

Our woven fabrics have high strength and stiffness as well as good thermal and electrical conductivity. They are compatible with different resin systems and hence permit tailored solutions for special applications.

### Material data of our SIGRATEX<sup>®</sup> woven fabrics

Material type	Weave	Areal weight [g/m <sup>2</sup> ]	Fineness of yarn warp [tex]	Fineness of yarn weft [tex]
<b>Carbon HT woven fabric</b>				
C W80-PL1/1	plain	80	70	70
C W95-PL1/1	plain	95	70	70
C W120-PL1/1	plain	120	70	70
C W160-PL1/1	plain	160	200	200
C W200-PL1/1	plain	200	200	200
C W200-TW2/2	twill 2/2	200	200	200
C W245-PL1/1	plain	245	200	200
C W245-PL1/1/SQ	plain	245	200	200
C W245-TW2/2	twill 2/2	245	200	200
C W245-TW2/2/SQ	twill 2/2	245	200	200
C W285-TW4/4	twill 4/4	285	200	200
C W300-PL1/1	plain	300	800	200
C W305-PL1/1	plain	305	400	400
C W305-TW2/2	twill 2/2	305	400	400
C W400-PL1/1	plain	400	800	200
C W410-TW2/2	twill 2/2	410	400	400
C W425-TW2/2	twill 2/2	425	800	800
C W500-PL1/1	plain	500	800	800
C W620-TW2/2	twill 2/2	620	800	800
C W665-TW2/2	twill 2/2	665	800	800
C W830-TW2/2	twill 2/2	830	1600	1600
<b>Carbon HM woven fabric</b>				
C W205-TW2/2	twill 2/2	205	225	225
<b>Carbon-glass woven fabric</b>				
H W135-PL1/1	plain	135	200	34G
H W175-PL1/1	plain	175	200	136G
<b>Carbon-aramid woven fabric</b>				
H W170-PL1/1	plain	170	200C/160A	200C/160A
H W215-TW2/2	twill 2/2	215	200C/160A	200C/160A

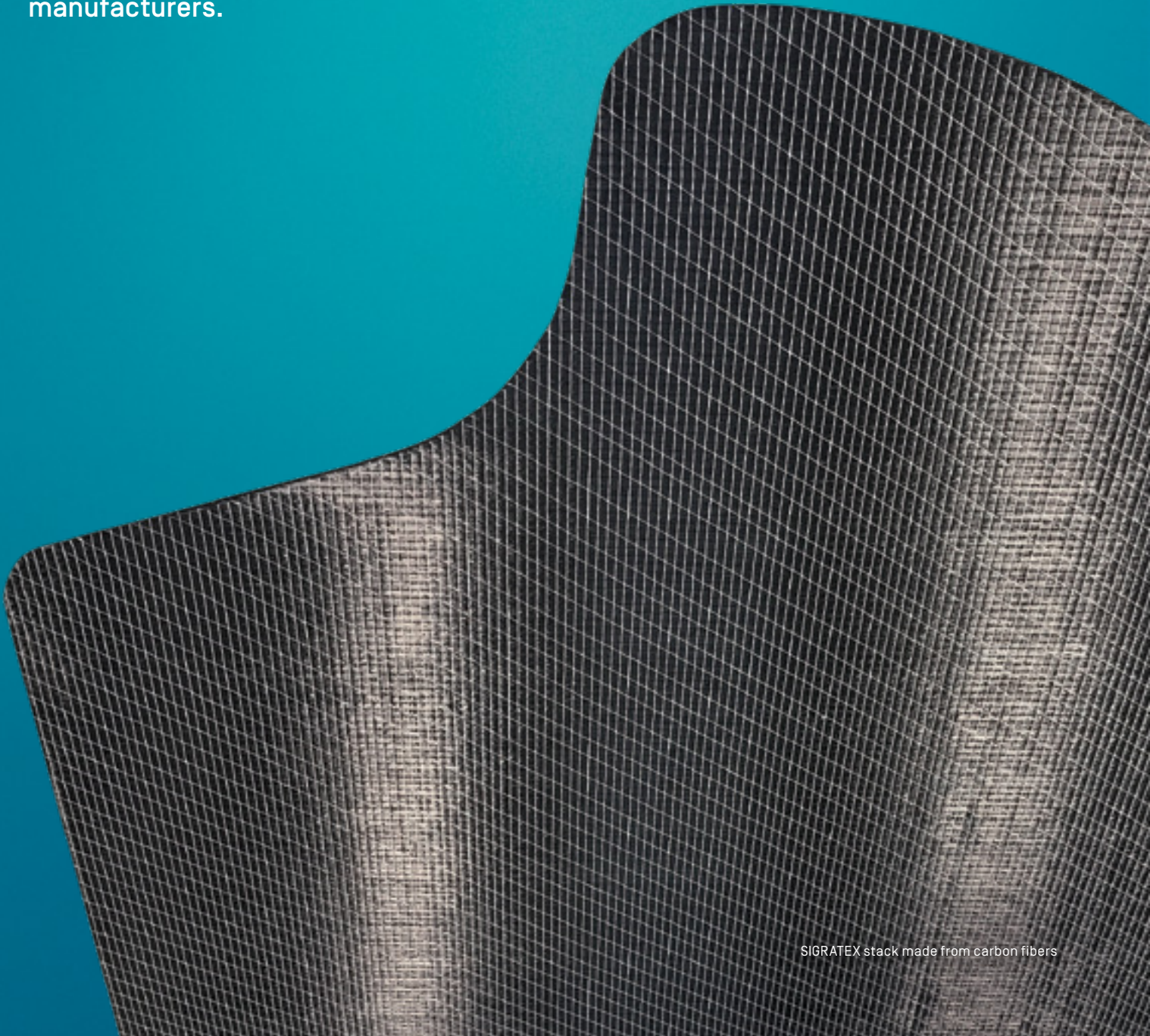
Other types and widths available on request. Fabric types can be produced with/without binder.

Abbreviations used: HM = high modulus, HT = high tenacity, C = carbon, A = aramid, G = glass

70 tex = 1k carbon fibers | 200 tex = 3k carbon fibers | 225 tex, 400 tex = 6k carbon fibers | 800 tex = 12k carbon fibers | 1600 tex = 24k carbon fibers

# SIGRATEX® stacks

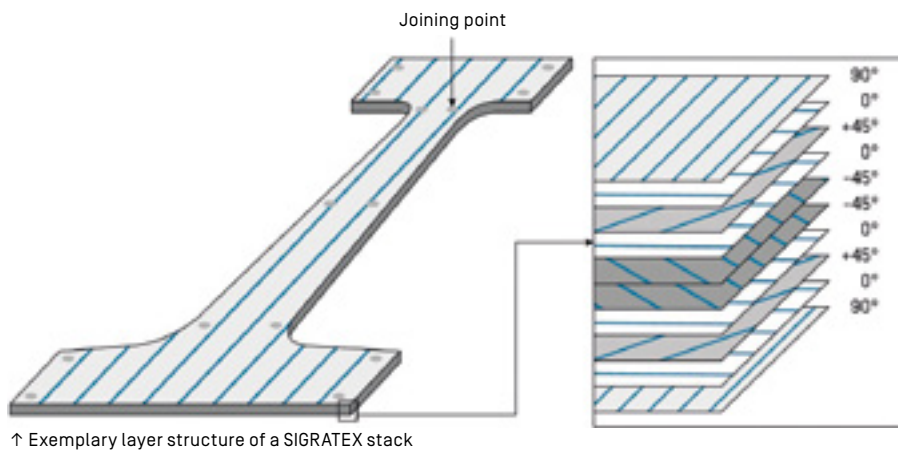
With SIGRATEX stacks, we offer precisely tailored and customer-specific assembled single textile layers made from carbon and glass fibers. The stacks are used as input material for the component-forming processes wet pressing and preforming/RTM and are thus the ideal textile solution for component manufacturers.



## SIGRATEX® stacks

A stack is a textile structure for further processing in the process chain for manufacturing CFRP components. The stack consists of different individual textile layers, which define the mechanical properties of the final component by material, number, orientation and grammage. These individual layers are stacked, cut to size and joined together by different joining processes.

With our stacking systems, larger geometries can also be realized, allowing larger components to be produced from one piece.

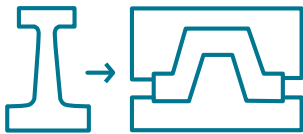


### Material data of our SIGRATEX® stacks

Properties	Units	Values
Maximum dimensions of the stack	mm	2200x1500
Maximum number of layers*	pc	13
Possible layer fixation/joining method		Spot-joining, full-surface joining
Textile semi-finished products		SIGRATEX non-crimp fabrics, woven fabrics, non-wovens
Contour/stack geometry		Acc. to CAD model (DXF.file or CAT.part)

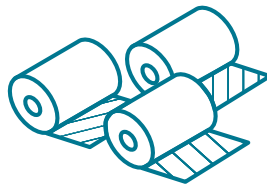
\*Depending on layer structure and semi-finished products

## What we offer to our customers



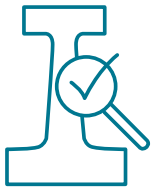
### The stack as a service – delivery directly to the press

To produce composite components, many upstream processes are necessary before a component is created. We take over the entire textile process steps, such as fabric production, layering and cutting, and supply the minimum necessary stacks for component production directly to the press.



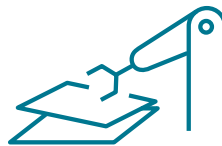
### Design freedom through textile selection

When selecting the right textile, the customer benefits from the design freedom within our broad textile material construction kit: different fiber orientations or basis weights, carbon or glass fiber or a mix of both – each individual layer in the stack can be freely selected.



### Our quality promise

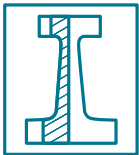
No defect leaves the factory - we guarantee 100% inspection of the individual layers by online measurement of the textile top and bottom. Defective areas in the material are communicated from the scrim line to the stack line. In the stack production, faults in the single layer in a stack are detected and the faulty stack is blocked for further processing. The stack contour as well as the position of labels and, if necessary, joining points are 100% monitored by optical measuring systems. Our certification according to IATF 16949 makes our quality performance transparent and proves our process capability and reliability over the entire value chain.



### From prototype to large-scale production

In our state-of-the-art plant park, we have created the ideal conditions for efficient stack production. We offer our customers the optimal solution here: from initial prototypes and small batches to large-scale production with quantities of up to one million units per year. The high degree of automation of the stacking line enables us to ensure product quality and production volume.





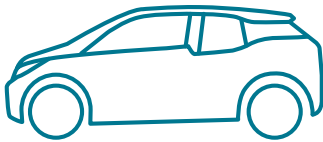
**Customized solutions**

We offer our customers tailor-made solutions for their applications. For example, our stacks can make optimum use of lightweight potential and component performance by introducing local reinforcement, e.g. with fiber placement technology. In addition, carbon fibers are applied where they are needed, enabling load-path-compatible construction.



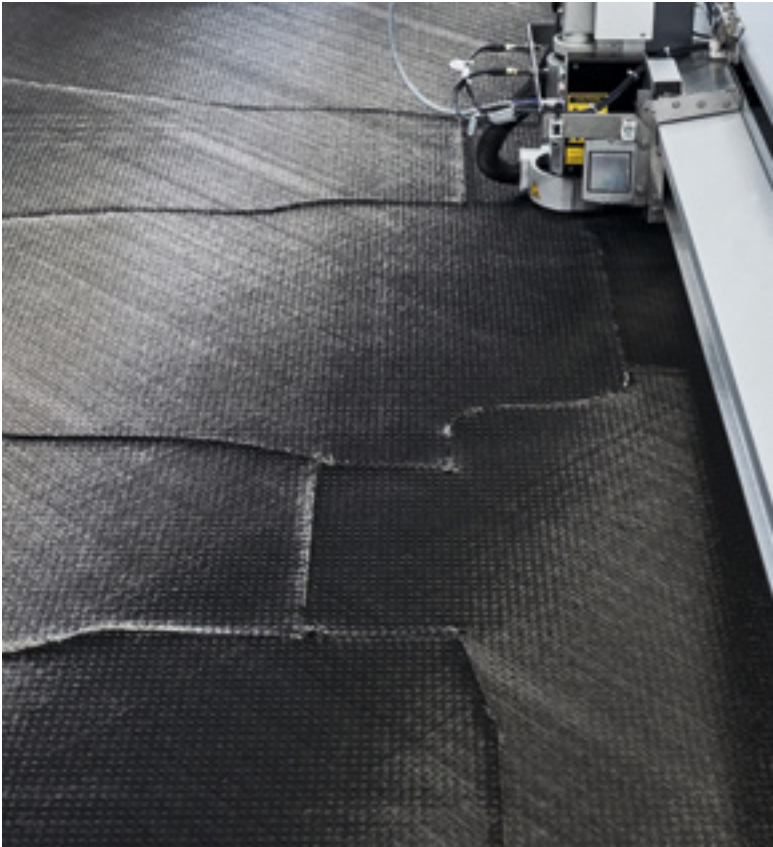
**No waste**

We take care of the annoying waste disposal: A waste-optimized stack is already generated during configuration. The near-net-shape stacks are delivered directly to the customer's press. This eliminates the trimming of textile semi-finished products and the storage and disposal of off-cuts for our customers.



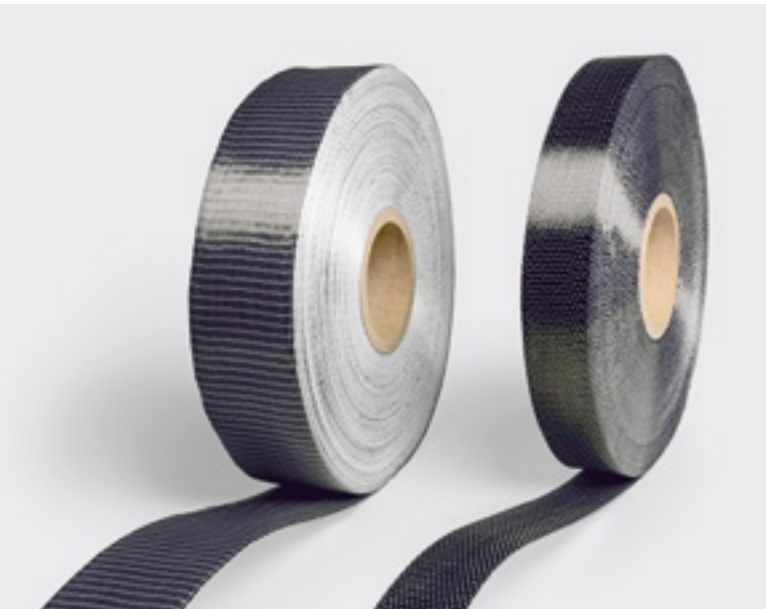
**Automotive expertise**

Our stacks are the result of decades of experience. As a long-standing partner, we have been producing carbon fibers, semi-finished products, and stacks for the automotive industry for over 10 years. In the process, the joint venture together with BMW has advanced our expertise in large-scale production. Our material systems and production technologies are designed so that all components can be mass produced. Components can be manufactured in large series.



↑ Cutting of the layered individual plies

## SIGRATEX® woven tapes



↑ SIGRATEX woven tapes made from carbon fibers

Narrow SIGRATEX tapes complete our woven fabric portfolio. They are excellently suited for additional local reinforcement of fiber composite components.

### Material data of our SIGRATEX® woven tapes

Material type	Weave	Areal weight [g/m <sup>2</sup> ]	Width [cm]	Fineness of yarn [tex]	Binding warp/ glass auxiliary warp
H U140-PL1/1	0°	140	6.5	200C/160A	
C U200-PL1/1	0°	200	5   10	200	
C W210-PL1/1	0°/90°	210	5   7   10	200	
C U270-PL1/1	0°	270	7.5	800	●
C U280-PL1/1	0°	280	3.5	200	●
C U285-PL1/1	0°	285	4.5	400	
C U290-PL1/1	0°	290	2.8   7.5   10	400	
C U290-PL1/1	0°	290	4.5	800	●
C U330-PL1/1	0°	330	7.5	400	●
C U330-PL1/1	0°	330	16	400	
C U360-PL1/1	0°	360	2.5	400	●
C U365-PL1/1	0°	365	5   10	800	
C U370-PL1/1	0°	370	16	800	

Other types and widths available on request. 200 tex = 3k carbon fibers | 400 tex = 6k carbon fibers | 800 tex = 12k carbon fibers.  
Abbreviations used: C = carbon, A = aramid

## SIGRATEX® non-wovens

Our non-wovens based on carbon fibers offer very good drapability and are a highly suitable raw material for prepreg production. The isotropic non-wovens are characterized by uniform distribution of fibers over a maximum width of 1500 mm.

The textile waste generated during production and stacking forms the basis for the manufacture of our isotropic non-wovens.



↑ SIGRATEX isotropic non-wovens made from carbon fibers

### Material data of our SIGRATEX® carbon fiber non-wovens

Material type	Total areal weight [g/m <sup>2</sup> ]	Carbon fiber content [g/m <sup>2</sup> ]	Glass fiber content [g/m <sup>2</sup> ]	Polymer fiber and binder content [g/m <sup>2</sup> ]	Fiber length [mm]
<b>Isotropic carbon fiber non-wovens</b>					
C N450-IS/NF	450	91	3	6	40
C N530-IS/NF	530	86	3	11	40

Other types available on request.

### Material data of our SIGRATEX® carbon fiber wet-laid non-wovens

Material type	Areal weight [g/m <sup>2</sup> ]	Binder type	Binder mass content [%]	Tensile strength N/15 mm	Fiber length [mm]
C N20-T220/10%	20	polyester styrene-soluble	10	20	6/12
C N30-T210/10%	30	polyvinyl alcohol	10	30	6/12

Other types available on request.

# Successful together

Textile products that bring the greatest possible added value for our customers are both our challenge and our promise. Every day we invest our decades-long experience, unique material expertise, and in-depth application know-how to keep this promise.

Our portfolio of textile reinforcing materials already covers numerous industrial application requirements. And where our products do not as yet fit a requirement, we simply adapt them so that our customers can produce their components as cost-effectively and efficiently as possible.





## Visible textile applications: How components and producers can look good

### Reliable supplier of proven 3k woven fabrics

When it comes to first impressions, there is no second chance. Visible carbon structures communicate premium quality entirely without words. For years, SGL has been an established supplier of high-quality 3k woven fabrics for classic CFRP applications in the visible applications. Our woven fabrics are proving successful all over the world in automotive products and other challenging applications.

### Development partner for innovative products

As a forward-looking technology company, we are open to new ideas and are pleased to work in partnership with our customers on the development of innovative products. Our experts can contribute unique know-how to these joint projects. Tailored textile architecture such as hexagonal stitching is a good example of this successful partnership.

# Smart Solutions

Be it materials, components or production processes, we put our customers first. With our in-depth material, engineering, and application know-how, we develop customized, reliable and high-quality solutions for our customers.

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

## Mobility

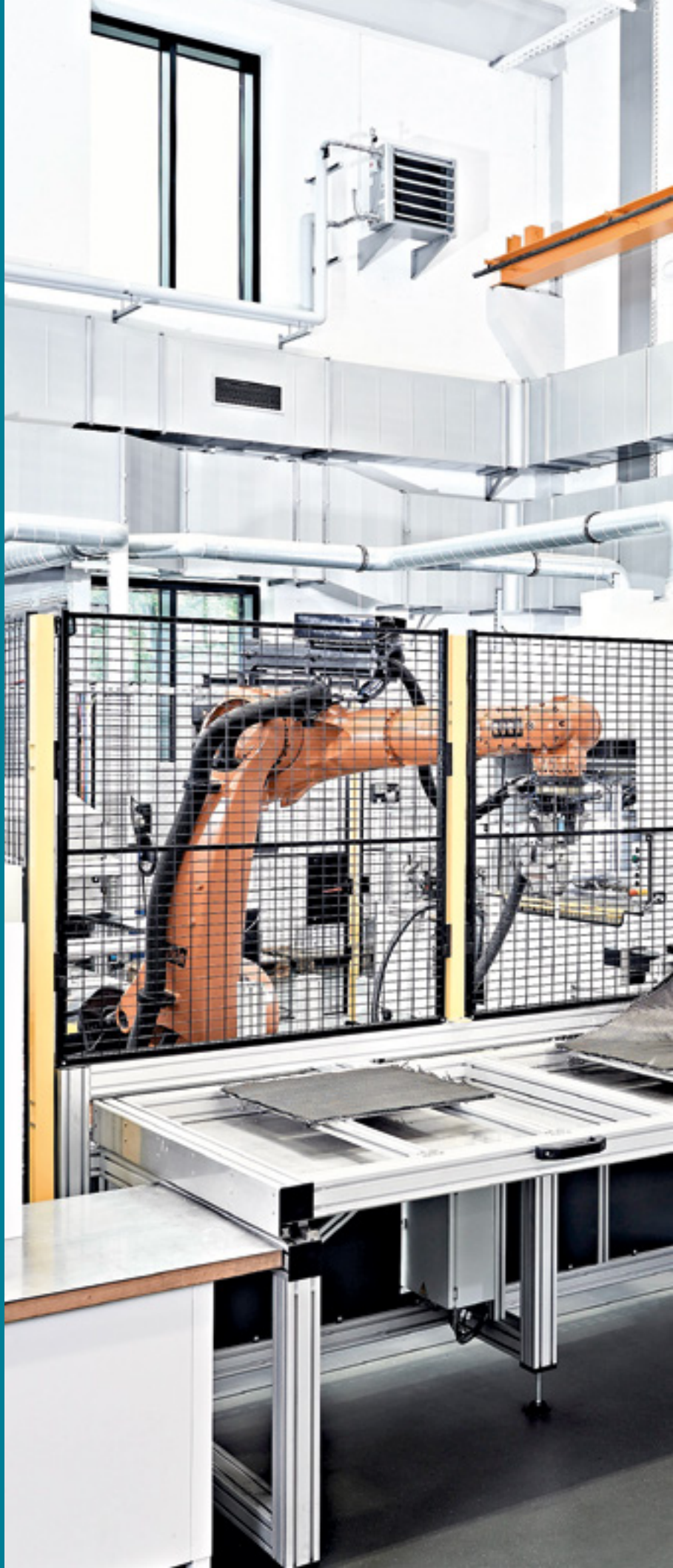
- Lightweight components and structural parts based on fiber-reinforced composites for automotive and aerospace manufacture
- Graphite anode material for lithium-ion batteries in electric vehicles
- Carbon-ceramic brake disks for sports cars and luxury sedans

## 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



# SGL Carbon

We are a global leader in the development and manufacture of carbon-based solutions. Our materials and products made from specialty graphite, carbon fibers and composites serve many industries that are shaping the trends of the future: climate friendly mobility, semiconductor technology, LED, solar and wind energy, and the manufacture of lithium-ion batteries.

We are driven to grow with products and technologies that benefit society and reduce environmental and climate impacts.

Together with our customers, we develop intelligent and sustainable solutions that contribute to a smarter world.



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