Carbon Fiber Fabrics and Prepregs
for the Marine Industry

Composite Materials

Broad Base. Best Solutions.

SGL GROUP
THE CARBON COMPANY

Carbon is Future.

SGL Group – The Carbon Company.

Carbon has unique properties. It is indispensable in the production of steel, aluminum and solar energy systems. Carbon increases the performance of wind turbines and reduces the weight of airplanes, cars and sports equipment.

Carbon substitutes other materials and contributes to a reduction in CO_2 emissions.

SGL Group is one of the leading manufacturers of carbon-based products and has the broadest product and technology portfolio, a global sales network and state-of-the-art production sites in Europe, North America and Asia.

Carbon Fibers & Composites

The Business Area Carbon Fibers & Composites (BA CFC) encompasses the complete value chain of carbon fiber products – from precursor via carbon fibers, fabrics and prepregs to finished CFRP composite parts.

We are the only European-based carbon fiber producer and have secured our own precursor supply. BA CFC has established a full range of downstream production technologies to provide its customers with a broad range of carbon products. Our materials portfolio is completed by glass fiber-based non-crimp fabrics and special technological developments like automated braiding in our joint venture SGL Kümpers.

Our subsidiary Hitco Carbon Composites has been supplying composite parts to the aerospace industry for many years now. To support the growth of the wind energy industry, our joint venture SGL Rotec is producing rotor blades for on- and offshore wind turbines. The automotive industry is supplied through our joint ventures Benteler SGL and Brembo SGL Carbon Ceramic Brakes.

We strive to be the leading carbon supplier to strategic growth industries with customized solutions from our broad product portfolio.

Carbon Fiber-Based Composite Materials

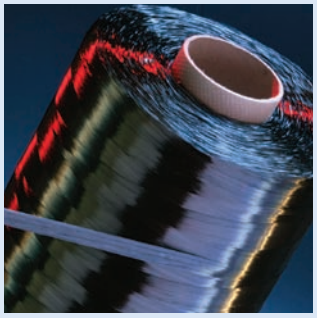
for High-Tech Marine Applications

Carbon fibers produced in-house at our sites in Europe and North America form the basis for our composite product range. Our own weaving facilities and prepreg plants cover the complete value chain. Our multiaxial fabrics and prepregs are used in yacht building and mast making in various sectors of the marine industry.

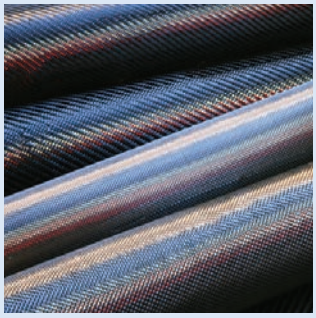
Through systematic investment in research and development, we have acquired unique know-how on the development of materials and processes for composites. Such know-how has been incorporated into our unique range of products that deliver real benefits to the user.

Benefits

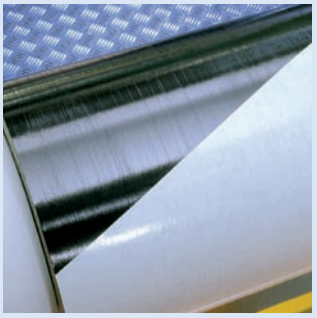
- High strength and high stiffness
- Corrosion resistance
- Chemical resistance
- Enhanced durability and ductility
- Light weight
- Ease of handling and processing



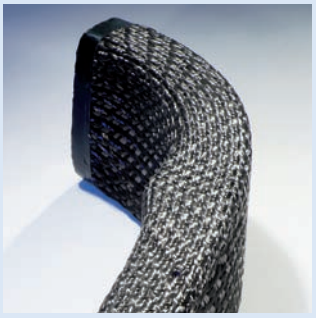
Carbon fibers



Fabrics



Prepregs



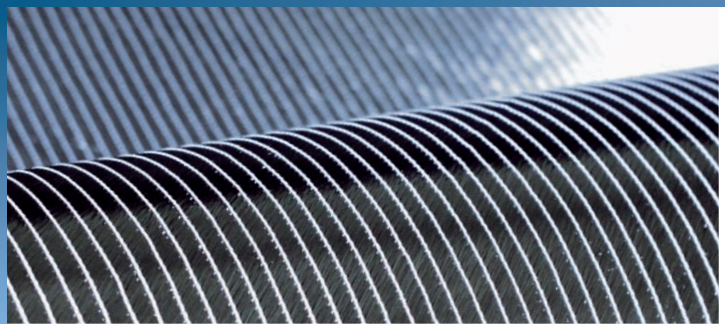
Preforms

Our carbon fiber and our composite testing lab are GL certified for the marine sector

Picture credits: Knieriem Yachtbau GmbH, Kiel/Germany

Unidirectional and Multiaxial Carbon Fabrics

Optimum for the Vacuum Infusion Process



Benefits

- Good drapability
- Good permeability for resin infusion
- High efficiency using less layers

Applications

- Large components
- Hulls, floor panels

Unidirectional and multiaxial fabrics based on SIGRAFIL C30 carbon fiber

Product	Direction [°]	Weight per layer [g]	Weight per unit area [g/m²]	Dry thickness [mm]
Unidirectional carbon fiber fabrics				
HPT 320 C0	0	300	320	0.3
HPT 440 C0	0	400	439	0.4
HPT 520 C0*	0	472	519	0.5
HPT 620 C0	0	584	621	0.6
Biaxial carbon fiber fabrics				
HPT 300 C45	±45	145	296	0.3
HPT 410 C45	±45	200	406	0.4
HPT 450 C45	±45	220	446	0.45
HPT 620 C45	±45	300	606	0.6
HPT 300 C090	0/90	145	297	0.3
HPT 410 C090	0/90	200	407	0.4
HPT 450 C090	0/90	222	451	0.45
HPT 620 C090	0/90	300	607	0.6
Multiaxial carbon fiber fabrics				
HPT 610 C045*	0/±45	200	608	0.6
HPT 810-C04590*	0/±45/90	200	808	0.8

Standard roll length 50 m. *35 m

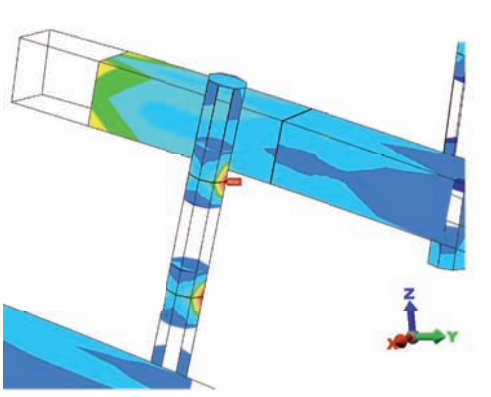
Unidirectional and Multiaxial Carbon Fabrics

Design Allowables for Engineers

Technical data for composite designers and engineers

Mechanical properties of the composite material are an essential starting point for the design process and for reliable calculation.

Our certified composite testing laboratory supports our customers with design allowables for composite engineering.



Simulation of 3-Point-bending

Basic CFRP production data

Material: 4 layers of HPT 410 C45
Resin type: SICOMIN SR8100
Hardener: SD8822
Process: vacuum infusion at 0.7 bar
Curing: 60°C / 16 h

Physical properties of CFRP laminate*

Property	Unit	Value
Fiber type	-	C30
Fiber volume fraction	%	50
Void content	%	1.5
Tensile modulus	N/mm^2	54000
Tensile strength	N/mm^2	810
Tensile strain	%	1.5
Compressive modulus	N/mm^2	50500
Compressive strength	N/mm^2	490
Compressive strain	%	0.97
InterLaminar shear modulus	N/mm^2	3490
InterLaminar shear strength	N/mm^2	50
Allowable interlam shear strain	%	1.43
In-plane shear modulus	N/mm^2	3490
In-plane shear strength	N/mm^2	70.9
Allowable in-plane shear strain	%	2.03
Poissons ratio	-	0.040
Density	kg/m^3	1464
Structural ply thickness	mm	0.46
Actual ply weight	g/m^2	673

* based on HPT 410 C45

- All properties have been tested in the fibre direction i.e. at ±45° to the roll direction unless specified otherwise by the test standard.
- Values are average values
- No liability is assumed by SGL Group through the use of this data. These mechanical properties have been derived from a specific processing method under specific conditions to prove an equivalency. The user needs to ensure that the intended manufacturing process produces laminates with properties thar are equivalent or exceed these mechanical properties should these values be used for design purposes.

Test standards

Tensile strength	DIN EN ISO 527-5
Compressive strength	DIN EN ISO 14126
In-plane shear strength	DIN EN ISO 14129
Interlaminar shear strength	DIN EN ISO 14130

Tested in SGL's GL certified composites testing lab

Prepregs
for Highly Stressed Structures

Benefits
- Large in-house capacity (>6 million m^2/year)
- Online and offline process available
- High capacity and flexibility to customize even with small quantities
- Standard qualified resin systems

Applications
- Ideale for high preformance sailing masts, rudder stocks, foils, booms, etc.
- Structural components

Standard resin systems for prepregs*

Resin	Type	Tg °C	Curing temperature °C	Durability at RT (20 °C), days	Durability at -18 °C, months	Tack	Tough. modif.
FT 102	Epoxy	120	80 – 160	14	6	L/M/H	Yes
FT 109	Epoxy	110	80 – 160	70	12	M	Yes
FT 105	Epoxy	120	70 – 120	21	4	L/M/H	Yes
E 201	Epoxy	120	90 – 140	90	12	M	Yes
E 022	Epoxy	140	100 – 150	90	12	L/M	No
E 030	Epoxy	> 180	120 – 180	90	12	L/M	No

* Customized systems and adhesive films available on request

Prepregs

Design Allowables for Engineers

Technical data for designers

We combine high-grade resin systems, formulated in-house, with ultramodern reinforcing materials.
The resulting materials feature maximum performance combined with minimum weight and optimized to match your own specific application.

Basic CFRP production data

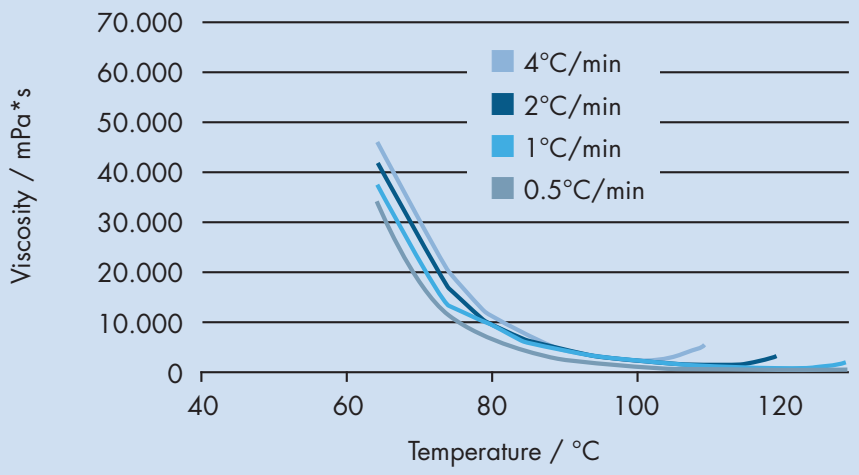
Material: Prepreg PR UD CS600/ 4 layers of 1250
Resin type: FT109
Process: autoclave 4.5 / -0.95 bar
Curing: 135 °C / 2 h
Test Standards: see page 5

Physical properties of CFRP laminate*

Property	Unit	FT109
Fiber type		SIGRAFIL C30 T050
Fiber volume fraction	%	61
Void content	%	1
Tensile modulus	N/mm^2	137000
Tensile strength	N/mm^2	2010
Tensile strain	%	1.43
Compressive modulus	N/mm^2	118000
Compressive strength	N/mm^2	1140
Compressive strain	%	1.1
In-plane shear modulus	N/mm^2	8400
In-plane shear strength	N/mm^2	60
Allowable in-plane shear strain	%	1.9
Poissons ratio		0.040
Density	kg/m^3	1.55

* based on UD carbon fiber prepreg
Liability: see page 5

Viscosity curve for epoxy resin FT109



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