

ADVANCED COMPOSITES

Advanced thermoset and thermoplastic composite products for medical applications



**PERFORMANCE COMPOSITES
SELECTOR GUIDE FOR MEDICAL**

TENCATE ADVANCED COMPOSITES

Protecting people

Overview

TenCate Advanced Composites is a market leading developer and manufacturer of advanced thermoset and thermoplastic materials for both industrial and aerospace applications.

Our thermoset based advanced composite prepregs are available in fabric and unidirectional (UD) tape form. TenCate utilizes both film impregnation and direct impregnation, controlling the resin content as well as the degree of impregnation to meet unique handling and processing requirements for each customer. We work with carbon, glass and aramid based reinforcements and a wide variety of proprietary resin systems ranging from low cost epoxies to high temperature BMIs.

With over 30 years of experience and pedigree, TenCate Cetex® and TenCate CFRT® set the standard for high quality, engineered thermoplastic composite materials. Drawing on this experience, we have expertise in amorphous and semi-crystalline thermoplastics. From PP, PA6 and PMMA all the way to PEI, PEEK and engineered PAEK, we can tailor the polymer to meet the demands of your application.

TenCate Cetex® thermoplastic materials are provided in UD tape, fabric and laminate forms to facilitate your manufacturing process and part design. Additionally, our continuous fibre reinforced thermoplastic (TenCate CFRT®) can be pre-consolidated, cut and kitted to customer requirements.

MEDICAL

TenCate Advanced Composites has a broad range of composite material solutions to suit the diverse applications within the medical market.

Continually investing in product development, we have a portfolio of thermoset and thermoplastic materials that have been developed specifically for use within medical applications including:

- › X-ray couches, tables and mammography plates
- › MRI scanners and C scanner components
- › Surgical target devices and tools
- › Prosthetics e.g. springs
- › Orthotics e.g. anterior foot, podiatric correcting in-soles, braces
- › Walking aids and wheel chairs

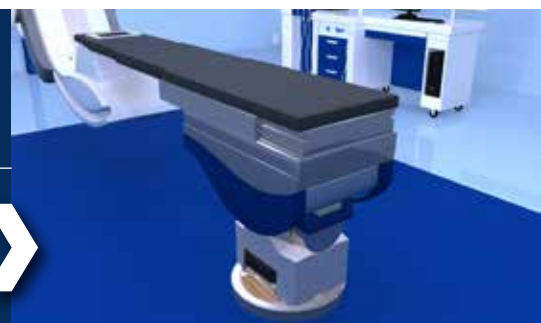
Properties of our materials include:

- › High strength to weight ratio
- › X-ray transparency
- › Heat resistance for steam sterilisation and excellent solvent resistance
- › Excellent cosmetic finish
- › Excellent damping and shock attenuation and resiliency
- › Enhanced energy return (spring) and response
- › Light weight and thin – minimise weight to reduce fatigue and stress
- › Tailored properties – varying degrees of stiffness



C scanner arm manufactured from TenCate E722 carbon fibre 500 gsm UD tape

X-ray table made with woven carbon with TenCate E726 carbon fibre 205 gsm 2x2 twill and carbon 200 gsm UD tape





THERMOSET PRODUCTS

Fabrication of medical components and devices are simplified through the use of medium temperature curing preregs providing high strength with easy processing. Available in carbon or glass reinforcements in UD tape or woven format.

Product name	Resin type	T _g	Typical cure time / Cure temp	Key product characteristics	Application examples	Reinforcement	
						UD tape	Fabric prepreg
TenCate E722	Epoxy	120°C (248°F)	60 minutes at 120°C (248°F)	High rigidity	Wheelchair frame, rims and mud guards	○	○
TenCate E720	Epoxy	110°C (230°F)	60 minutes at 120°C (248°F)	Progressive flex, honeycomb bondable	ARO (anterior foot orthoses), braces	○	○
TenCate E726 NEW	Epoxy	105°C (221°F)	60 minutes at 120°C (248°F)	X-ray transparent. Higher degree of toughness. Excellent drapability	Prosthetic springs, X-ray couches, tables and mammography plates	○	○

For thermoset set products offered within Europe, TenCate can provide kit cutting services, tailoring the shape to customer specifications. In order to maximize material out life, all TenCate cutting services are performed in a controlled environment. Through a customer CAD file, drawing or sample, TenCate's automated cutting equipment can deliver any shape desired.

THERMOPLASTIC PRODUCTS

TenCate Cetex® laminates are engineered to meet the structural demands of volume applications including orthosis.

PERFORMANCE THERMOPLASTICS

Laminate	Resin type	TenCate Cetex® product	Style	Thickness (mm / in)	Rigidity (N-cm ² / lb/in ²)	Modulus (GPa / Msi)	Strength (MPa / ksi)
TL-2100	PMMA	TC951	Semi-Flex ¹	1.78 / 0.070	124 / 42.4	11.0 / 1.6	363 / 53
TL-2100	PMMA	TC951	Semi-Rigid ¹	2.29 / 0.090	240 / 82.0	9.7 / 1.4	337 / 49
TL-2100	PMMA	TC951	Rigid ¹	2.79 / 0.110	424 / 144.9	9.0 / 1.3	282 / 41
TL-2100	PMMA	TC951	Ultra ¹	2.92 / 0.115	468 / 159.9	10.3 / 1.5	302 / 44
TL-6000-2L	PMMA	TC951	3x1 twill weave ²	2.20 / 0.087	365 / 124.7	17.2 / 2.5	376 / 55
TL-6000-MOD1	PMMA	TC951	3x1 twill weave ²	2.92 / 0.115	1600 / 546.7	29.0 / 4.2	329 / 48
TL-6000-3L	PMMA	TC951	3x1 twill weave ²	2.95 / 0.116	1434 / 490.0	28.6 / 4.1	335 / 49
TL-6000-4L	PMMA	TC951	3x1 twill weave ²	3.43 / 0.135	2487 / 849.8	28.3 / 4.1	454 / 66

All RTL panels are supplied with 0.178mm (.007") films on the outside with the exception of TL-6000-MOD1 (TC951).

¹ TenCate Cetex® TL-2100 (TC951) is commonly supplied within moisture resistant bags, in dried pre-cut rectangular plates with a full radius on one end for enhanced forming of heel cups, for ease of distribution to podiatry laboratories. It is also available as 1220 x 910 mm panels. Its custom-designed weave provides additional stability, support and bio-mechanical correction of the foot in the lateral and medial orthotic direction.

Size	TenCate Cetex® TL-2100 (TC951) dimensions		
1	76.2 x 177.8 mm	3.0 x 7.0 inches	Sizes 1 and 3 are not available in the Ultra Strength grade.
3	88.9 x 190.5 mm	3.5 x 7.5 inches	
4	101.6 x 203.2 mm	4.0 x 8.0 inches	
5	101.6 x 215.9 mm	4.0 x 8.5 inches	Additional sheet sizes are available on a factory special order basis.
6	127 x 228.6 mm	5.0 x 9.0 inches	

² TenCate Cetex® TL-6000 (TC951) woven carbon fibre laminates provide high mechanical properties and are cut to customer specifications from 910 x 1220 mm (36 x 48 in) sheets. Typical applications are lower limb orthoses such as knee and ankle bracing.

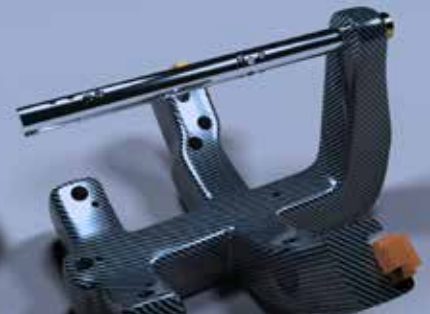
ENGINEERED THERMOPLASTICS

TenCate Cetex® product	Resin type	T _g / T _m (for semi-crystalline resins)	Key product characteristics	Application examples	Product format		
					UD tape	Prepreg	RTL
TC1000 Design	PEI	217°C (423°F)	High strength / stiffness Heat resistant Good chemical resistance	Abdominal retractors, external fixators, surgical instruments		○	○
TC1225 NEW	PAEK	147°C (296°F) T _m 305°C	Low moisture absorption Cost effective	X-ray, surgical target devices		○	○
TC1200	PEEK	143°C (289°F) T _m 343°C	Excellent strength / stiffness Excellent solvent resistance	X-ray, surgical target devices	○	○	○



Prosthetic manufactured from TenCate E720

Surgical target device made using TenCate Cetex® TC1200



TENCATE CETEX® AND TENCATE CFRT®

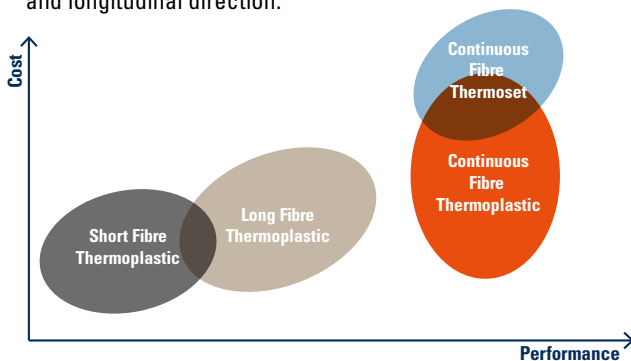
Thermoplastic materials

The material edge

TenCate Performance Composites is the leading supplier of high performance continuous fibre reinforced thermoplastic into the medical market. TenCate CFRT® thermoplastic composites can be found under the feet of more than 5 million patients who require podiatric correction. Additionally, TenCate's advanced composites are used for high performance braces in the orthopaedic profession.

TenCate deploys advanced manufacturing fabrication technologies which provides reinforced thermoplastic laminates (RTLs) which are of higher consistency and accuracy. The TenCate CFRT® thermoplastic materials are "tunable" meaning that the materials can be tailored to increase or limit the range of foot motion with fibre replacement, resin mix and component design. Fibre type, content and placement can be selected to provide the greatest mechanical properties in the desired direction.

Similar to a continuous "bridge", TenCate CFRT® materials provide engineered strength from one end of the component to the other. This allows the designer to develop an orthotic component with different characteristics in the medial lateral and longitudinal direction.



SHEET MANUFACTURING

TenCate Performance Composites has vertically integrated manufacturing ensuring timely delivery of high quality components to customers. On site processes include resin formulation, prepreg and laminate fabrication. Laminates allow various plies to be oriented and consolidated, and also allow rapid thermoforming.



HIGH VOLUME COMPONENT MANUFACTURING

Using CAD/CAM programming and the latest waterjet technology, component parts are cut quickly and efficiently from the laminates. Material utilization is maximized and tooling costs are minimized compared to other cutting processes. The waterjet-cut flat component patterns are then formed in seconds using relatively inexpensive tooling.

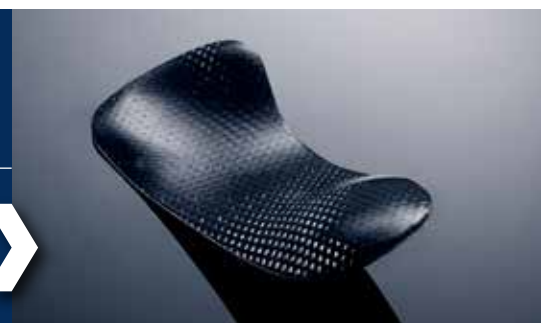
THERMOPLASTIC PROCESSING

Fully consolidated laminates are typically used in secondary thermoforming operations for fast part production. Materials may also be reformed and recycled. The thermoplastic forming time takes only seconds, not minutes or longer facilitating cost effective part fabrication.



Wheel chair and walking aids with TenCate E722 carbon fibre 205 gsm 2x2 twill and 650 gsm 2x2 twill

Orthotic foot insert manufactured from TenCate Cetex® TC951



TENCATE
Cetex®

TENCATE
CFRT®

MATERIAL COMPARISONS AND COMMON COMPOSITE FABRICS

Material vs. reinforcements	Filament count	Tensile strength	Tensile modulus	Density g/cc
Steel	N/A	400 MPa / 58 ksi	200 GPa / 29 Msi	7.8
Aluminium	N/A	483 MPa / 70 ksi	69 GPa / 10 Msi	2.8
E-Glass ³	N/A	2,000 MPa / 290 ksi	72 GPa / 10 Msi	2.6
High Strength Carbon ³	3K, 12K (also 18K, 24K, 48K)	3,447 - 4,826 MPa / 500 - 700 ksi	230 - 245 GPa / 33 - 36 Msi	1.8
Intermediate Modulus Carbon	6K, 12K	~5,516 MPa / ~800 ksi	275 - 304 GPa / 40 - 44 Msi	1.9
High Modulus Carbon	6K, 12K	~3,965 MPa / ~575 ksi	>340 GPa / >49 Msi	1.8

³ These fibre types are also available as unidirectional (UD) tape

Table of standard weave styles for fabrics		Areal weight (gsm / oz / yd ²)	Description
E-Glass	Plain Weave	200 / 5.90	Lowest cost option
Carbon	Plain Weave 3K	193 / 5.69	Good fabric stability, but less drapable
	2x2 twill 3K 2x2 twill 12K	205 / 6.05 650 / 19.17	More drapability than PW, less stable
	4x4 twill 3K	283 / 8.35	Flatter weave style than 2x2 twill, improved finish

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