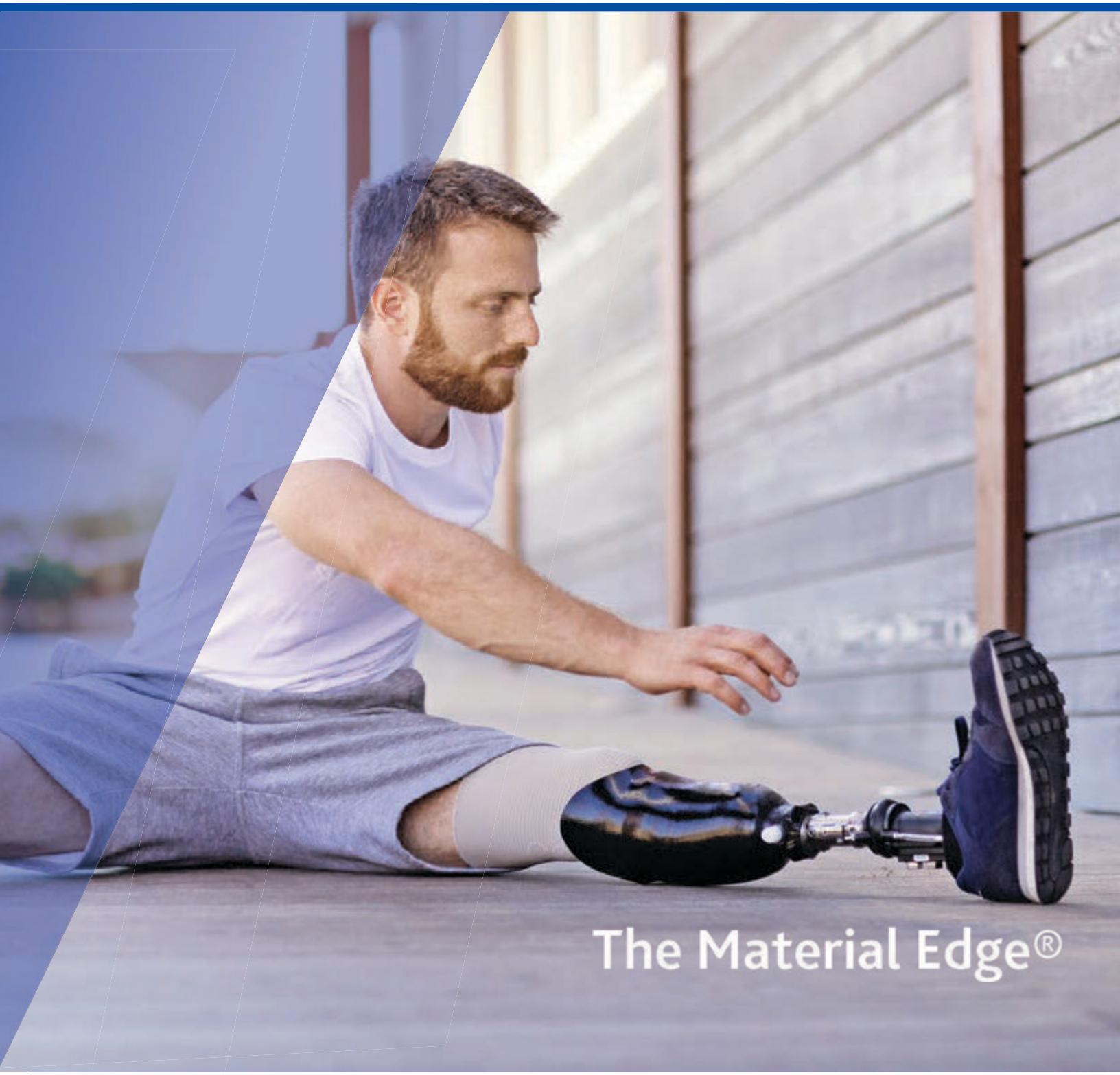
TORAY CFRT®

Medical Materials Selector Guide



TORAY

Toray Performance Materials Corporation

OUR OBJECTIVES

- Enineered Solutions
- Product Performance
- High-Volume Production
- Improved Cost Effectiveness

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Medical Materials Selector Guide

> Contributing to society through the creation of new value with innovative ideas, technologies, and products.

INTRODUCTION TO TORAY PMC

Materials Technology and Capabilites

Toray Performance Materials Corporation (TPMC) began as Medical Materials Corporation (MMC) in 1986 and was founded by William R. Olson, D.P.M, a leading University of California, Berkeley team Podiatrist. The primary market for MMC was medical foot orthotics. This was the beginning of the TPMC "TL" brand which continues to be the foremost premium orthotic material on the market today. As of now, we have produced tens of millions of thermoplastic composite components for diverse applications including athletic footwear, orthopedic devices, automotive, consumer electronics, recreational and industrial.

Since our acquisition by Toray Industries Inc. in July 2018, this has signaled the beginning of a new era, continuing the legacy of innovation and service, now with the strength of the Toray Group behind us to provide the ultimate value to our customers.

Thermoplastic Composite Solutions

TPMC is the leading supplier of Toray CFRT® which are continuous fiber-reinforced thermoplastic composite materials, components, and solutions.

We help companies realize the advantages of thermoplastic composites as advanced structural reinforcements through the integration of engineered solutions and downstream processing. It's this vertical strength coupled with the advantages of thermoplastic composites that enables our customers to achieve innovations in their products - innovations that provide cost, performance and aesthetics advantages exceeding that of more conventional reinforcement solutions.

Our thermoplastic composites are used to make better products in almost any market and application where composite materials can provide benefit. Our goal is not only to provide expertise in continuous fiber-reinforced thermoplstic composites, but also to truly understand and respond to the needs of the markets and customers that we serve.

Medical Materials Corporation (MMC) founded by Dr. Olson, D.P.M. and head of Podiatric Surgery at the Center for Sports Medicine at St. Francis Memorial Hospital, San Francisco.
1986

2000
MMC renamed to Performance Materials Corporation (PMC) and acquired Baycomp Company in Canada.

Sheet Manufacturing

TPMC's CFRT® vertically integrated manufacturing allows for lower production costs, greater flexibility, and fast delivery. TPMC's CFRT® factory is operated using computer-aided manufacturing systems. The manufacturing processes for producing Toray CFRT® materials includes resin formulation, prepreg, and lamination.

Multiple opening lamination presses produce high throughput of consistent composite sheet materials, while allowing for manufacturing flexibility. The thermoplastic panels proceed from lamination presses to cutting operations. The 3' x 4' (910 x 1220 mm) sheet materials are produced in a multitude of grades and aesthetic options.

High-Volume Component Manufacturing

Using CAD/CAM programming and the latest waterjet technology, component parts are cut quickly and efficiently. Material utilization is maximized and tooling costs are minimized compared to other cutting process.

The waterjet-cut flat component patterns are then formed in seconds using relatively inexpensive tooling. TPMC ships over a million high quality composite components every month to facilities around the world. TPMC's integrated factor ensures timely delivery of high-quality components to customers.

TPMC CFRT® composite materials are offered in both woven and uni-directional formats. Our technology blends the benefits of a thermoplastic polymer matrix with fiber reinforcement. The result is a synergistic material with greater strength than the two alone.

2012
PMC was acquired by Tencate Group

Baycomp Company closed. PMC acquired by Toray Industries Inc.

2018

2019
TL product line of orthotic CFRT® materials celebrates over 30 years of proven performance as. Continues the legacy as the leading orthotic material on the market today.

GLOBAL LOCATIONS

Camarillo, California, USA | Headquarters and Manufacturing Plant
1150 Calle Suerte, Camarillo, CA 93012 USA
T: +1 805 482 1722
Contact: l.calligaris@toraypmc.com

Guangzhou, China | Manufacturing Plant
Bldg. 11 #48 Hongmian Ave. Xinhua Town,
Huadu District, Guangdong Province, Guangzhou, China
T: +1 86 20 3687 2887 ext.2992
Contact: l.lin@toraypmc.com

Taichung City, Taiwan | Regional Office
No. 760 Zhongming S. Rd., South District
Taichung City, 402 Taiwan
Tel: +1 886 4 22606718
Contact: b.chen@toraypmc.com

THE MATERIAL EDGE®

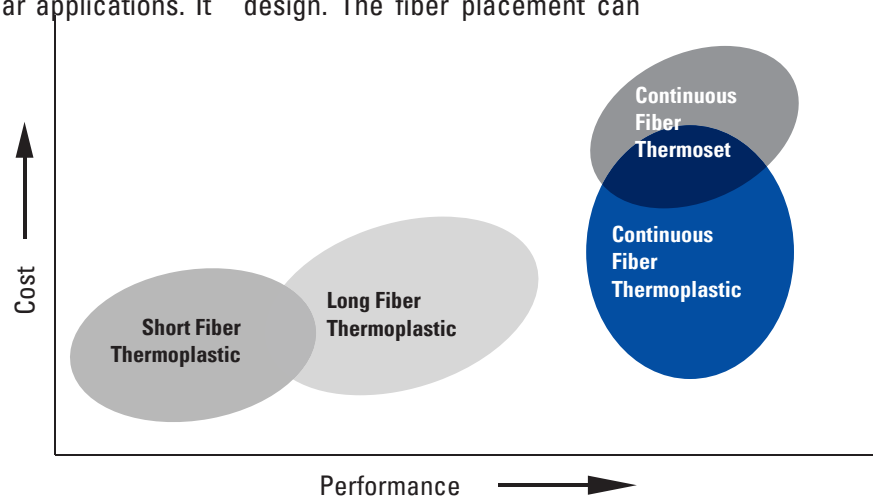
Toray CFRT® composite materials are used to enhance the performance of medical applications. Our materials have unique attributes and, when used strategically, they can reduce the weight of the product substantially while increasing biomechanical stability. Our materials are used in combination with other components to develop product designs that are truly engineered.

"Resilience" (spring or responsiveness) is a key performance attribute of Toray CFRT® composite materials that is found typically in Athletic Footwear applications. It is used to describe how the materials return to their original shape through millions of cycles; Thus, contributing to reduced foot fatigue and injury prevention.

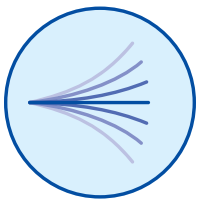
Toray CFRT® materials have performance and weight advantages over "chopped fiber reinforced" or "nonreinforced" injection molded materials.

Toray CFRT® composite materials are "tunable." They can be tailored to increase or limit the range of foot motion with fiber replacement, resin mix, and component design. The fiber placement can be selected to provide the greatest mechanical properties in the desired direction. Similar to a continuous "bridge," Toray CFRT® materials provide engineered strength from one end of the component to the other.

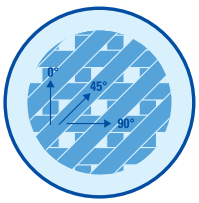
Toray CFRT® materials can be designed with different fiber types and content in each direction allowing for different properties in each direction. This allows the designer to develop a shoe component with different characteristics in the medial-lateral and longitudinal direction.



Lightweight



Resilient



Engineered Reinforced Orientation

LAMINATE STYLES

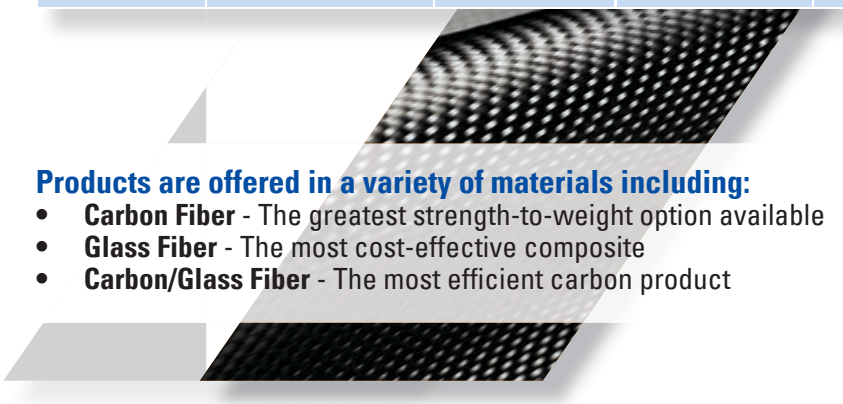
Our woven and unidirectional (UD) materials are offered in a variety of styles and fiber (carbon and/or glass) combinations. The resin matrix systems used in Toray CFRT® materials offer unique processing and property characteristics to match a broad range of structural and service requirements.

Uni-directional (UD) series - Our CFRT® UD series of laminates are continuous fiber reinforced thermoplastic composites that blend the benefits of a thermoplastic polymer matrix with uni-directional glass and/or carbon fibers for enhanced cost-effective performance. UD laminates can be multilayer products that are engineered to deliver properties including lightweight support, resiliency, and energy return.

Woven series - Our CFRT® woven lamiantes are offered in a variety of weave styles and fiber (carbon and/or glass) combinations. Similar to the UD series, each laminate construction is chosen for its own unique performance, aesthetic, and economic attributes.

Orthopedic Laminate Styles

Fiber Reinforcement	Laminate Style	Resin	Style	Thickness mm	Rigidity N-cm	Modulus GPa
Carbon	TL-6000-MOD1	PMMA	Twill Weave	2.74 –3.20	6700	29
Carbon	TL-6000 2L	PMMA	Twill Weave	1.98 –2.41	1410	16.5
Carbon	TL-6000 3L	PMMA	Twill Weave	2.74 –3.18	3500	15.5
Carbon	TL-6000 4L	PMMA	Twill Weave	3.43–3.71	9935	28.4
Glass	XRP 110	Polypropylene	Unidirectional	1.50	458	17.6
Glass	XRP 112	Polypropylene	Unidirectional	1.78	580	13.9
Glass	XRP 114	Polypropylene	Unidirectional	2.28	1043	9.1
Glass	XRP 116	Polypropylene	Unidirectional	3.32	2330	7.1

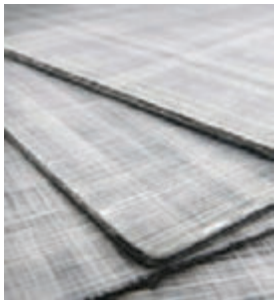


Products are offered in a variety of materials including:

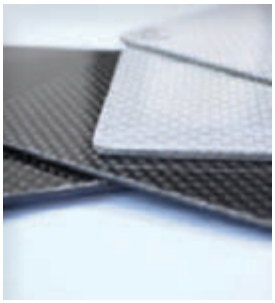
- **Carbon Fiber** - The greatest strength-to-weight option available
- **Glass Fiber** - The most cost-effective composite
- **Carbon/Glass Fiber** - The most efficient carbon product

CFRT®

Toray CFRT® TL-6000



Toray CFRT® XRP



Toray CFRT® TL-2100 and TL-Silver

Toray CFRT® XT and XTX

Podiatry Laminate Styles

Fiber Reinforcement	Laminate Style	Resin	Style	Thickness mm	Rigidity N-cm	Modulus GPa
Carbon	TL-2100 Semi-Flex	PMMA	Plain Weave	1.78	495	11.0
Carbon	TL-2100 Semi-Rigid	PMMA	Plain Weave	2.29	835	8.6
Carbon	TL-2100 Rigid	PMMA	Plain Weave	2.79	1600	8.2
Carbon	TL-2100 Ultra Rigid	PMMA	Plain Weave	2.92	2075	9.5
Glass	TL-Silver Semi-Rigid	PMMA	Plain Weave	2.35	1130	8.5
Glass	TL-Silver Rigid	PMMA	Plain Weave	2.80	1450	7.5
Carbon/Glass	XTX Ease Flex	Polypropylene	Unidirectional	1.60	70-75	2.1
Carbon/Glass	XTX Semi-Rigid	Polypropylene	Unidirectional	1.90	288	4.8
Carbon/Glass	XTX Rigid	Polypropylene	Unidirectional	2.50	532	4.2
Carbon/Glass	XTX Ultra-Rigid	Polypropylene	Unidirectional	3.00	789	3.9
Glass	XT Ease-FLex	Polypropylene	Unidirectional	1.5-1.75	85	3.0
Glass	XT Semi-Flex	Polypropylene	Unidirectional	1.6-1.8	265	9.0
Glass	XT Semi-Rigid	Polypropylene	Unidirectional	1.85-2.0	600	6.7
Glass	XT Medium-Rigid	Polypropylene	Unidirectional	2.1-2.4	724	7.3
Glass	XT Rigid	Polypropylene	Unidirectional	2.4-2.65	920	5.3
Glass	XT Ultra Rigid	Polypropylene	Unidirectional	2.85-3.2	1350	5.3

MEDICAL APPLICATIONS

Foot Orthotics - Recommended for functional correction, the use of CFRT® materials for this medical application will help to stabilize and correct foot ailments while decreasing weight strain. CFRT® carbon or glass foot orthotics can be used to minimize pronation and supination. Our biomechanical heritage attributes to the vast product lines and material options we have available for Podiatrists and their patients.

NRG plates - Toray CFRT® NRG Plates are unique designs used in medical applications to limit motion such as with Turf Toe or Hallux Rigidus and partial foot amputations. They are also used to make improvements in patients' gait and to redistribute pressures to less sensitive areas of the foot for diabetic patients.

Sock Liner or Insole - Toray CFRT® composite materials can be used for sock liner or insole applications to provide added support just under the foot. Studies have shown that by using Toray CFRT® composite materials, it will reduce foot fatigue, improve stability, and increase comfort. The composite material is typically used as an outer shell beneath a top cover for the insole and since the material is thin and light, it will take up very little room in the shoe as compared to other materials. These key benefits contribute to the overall comfortability of the application.

Ankle Foot Orthotic (AFO) - Carbon and glass fiber options are available for maximum reinforcement, increased strength and increased stiffness of local areas in AFO designs. Our unidirectional composite matrices in particular have the ability to heat weld copolymer materials during the forming process. Our CFRT® materials are a result of a unique patented fiber impregnation technology developed for aerospace applications. They provide a barrier film for safety and comfort in AFO applications. Our materials and parts are easily molded to deep contours. They can be machined and finished using conventional equipment and heat adjusted.

Photos courtesy of Orthogolfer, Comfortfit and of the respective companies.

Knee Braces - Toray CFRT® composites provide superior stability and support, yet are lightweight and thin enough to minimize weight and to reduce fatigue and stress. Our materials are available in various constructions and formats to meet customer specifications.

Other types of orthoses and prostheses - Toray CFRT® reinforcement panels bring an innovative technology to orthotic and prosthetic applications. They satisfy both the workshop need for ease of fabrication and the patient need for comfort and performance. Parts and devices made from thermoplastic sheets, such as polypropylene, are reinforced in strategic locations by thermobonding for example, an XRP panel to a part during vacuum forming or drape molding. The result is a part with increased strength and stiffness, without having to raise the basic sheet thickness.

General Hospital Devices and Therapeutic Products - CFRT® materials may be used for medical applications that are non-invasive and where there is a need for lightweight, structural support. This may include but is not limited to: sheet materials for surgical tables or medical computer carts, electronic devices, monitors, and other applications. Please consult with our Sales team memebers for material recommendations.

TORAY CFRT® KEY BENEFITS:

Performance and weight improvements, biomechanical stability, cost effectiveness, tunability, and resiliency.

PROCESSING GUIDELINES

Toray CFRT® materials can be molded into composite components or devices using multiple forming options. CFRT® materials with hygroscopic resins, including: Nylon (PA6), Acrylic (PMMA), Polycarbonate (PC), and PET, must be dried for 24 hours prior to heating and forming. Polypropylene (PP) is non-hygroscopic and does not need to be dried prior to heating and forming.

Forming options:

- Vacuum forming
- Thermoforming with free edge closed mold
- Compression molding with match-die tool

The forming process that best suites the desired device or component is dictated by the complexity of the final molded component. With a higher forming pressure, more detail can be molded into the component part. Vacuum forming utilizes relatively low pressures, thermoforming utilizes moderate pressures, and compression molding utillizes high pressures.

Cutting

CFRT® materials can be cut with a band-saw or similar equipment. Our materials may also be cut with automated cutting systems using routing or high-pressure waterjet. The materials may be cut with or without abrasives.

Grinding

The material may be ground and polished using a stationary head grinder. Coarse grinding may be performed using 60–80 grit medium wheel. A 150–400 dry grit paper is recommended for final grinding. Edges may be polished with a cloth buffing wheel and compound. Contact with ground particles can cause skin irritation. Gloves, paper mask, safety glasses, and sleeves should be worn.

Drilling

Drilling can be accomplished using a standard drill press or handheld drill.

Heat Adjustment

Components can be heat-adjusted using a conventional industrial grade hot air blower.

Bonding

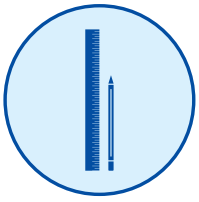
Our materials with acrylic-based systems provide excellent bonding results with all primers and adhesives.

Storage

Drying is needed of the material is exposed to ambient elements outside original packaging.

Please ask your Sales account manager for a copy of our Processing Guide for complete and detailed instructions or call us at +1 805 482 1722 if you have any questions!

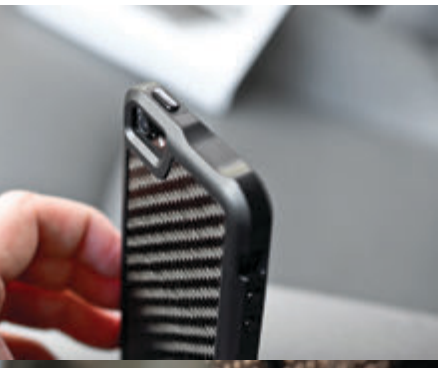
Color Options



Design Freedom

High Performance

DESIGNING WITH TORAY CFRT® MATERIALS



Transitional/Contour Areas - Minimum radius should be 6 mm.

Holes and Hole Placement - Holes are not recommended for designs that use Toray CFRT® materials as they disrupt the continuous fiber of the component. Holes may be incorporated into a design but we recommend to keep in mind that large holes, mulitiple holes, and holes close to the edge of the design, will weaken the composite and can cause catastrophic failure. Holes need to be addressed on a case-by-case basis. Please consult with our Engineering team about your specific design.

Flex Area - Materials placed in the flex zone will limit motion. Fiber placement and percent fiber content, will dictate the amount of motion limitation. For example, material running beyond the forefoot flex zone and around the forefoot will increase rigidity and limit flex.

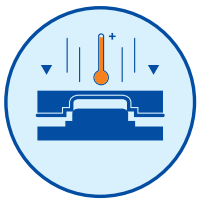
Arch Area - Use of an arch wrap as typically found in footwear, will add stiffness to the component part and will subsequently add stiffness to the shoe as well. Arch wrap angle, height, and radius will determine the amount of stiffness added to the footwear. Extreme wrap, height, or radius may cause foot discomfort.

Carbon Fiber - Carbon fiber represents a noticeable increase in stiffness and weight reduction from fiberglass. It is also thinner than fiberglass.

Carbon Direction - Materials are offered in all carbon, hybrid-carbon/glass, and all glass. In the hybrid material, the carbon direction will have more stiffness. Carbon should be used in the direction in which stiffness/resiliency is desired.

Exposed Areas - Toray CFRT® materials should be protected from objects that can cause abrasion, puncture, or fracture.

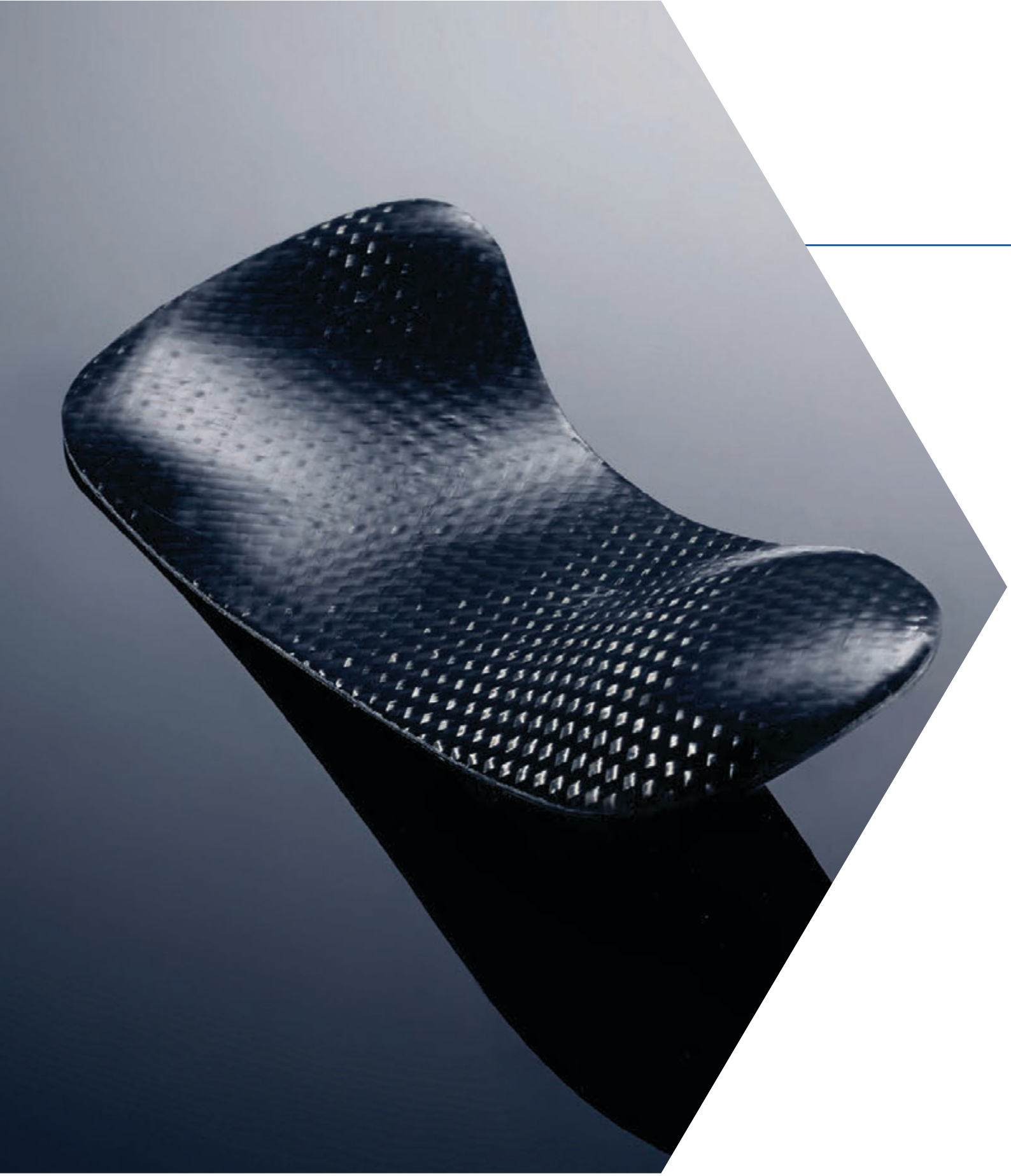
Component designs should be reviewed through Toray Development teams for composite soundness and optimization. Our composite engineers are available to assist you in your application. Please do not hesitate to contact us at +1 805 482 1722.



Thermoformable

Sustainable

Strong



PRODUCT HIGHLIGHTS

TORAY CFRT® TL-2100 SHEETS AND ORTHOTIC BLANKS

Product Highlight

DESCRIPTION

All grades of Toray CFRT® (TL-2100) consist of the same composition resin, carbon fiber, and laminate concept of our proprietary sandwich construction. The carbon fiber (graphite) provides strength, stiffness, and durability.

TL-2100 Semi-Flex, Semi-Rigid, Rigid, and Ultra differ only in terms of the volume of carbon fiber used and the thickness of the sheet material. TL-2100's custom-designed weave provides high-strength carbon fiber in the longitudinal direction of an orthotic.

FEATURES

- "Thin and Light" for proper fit within the shoe without raising the foot
- Custom-designed weave provides high-strength carbon fiber in the longitudinal direction of an orthotic to enhance stability
- A full radius on one end for enhanced forming of heel cups for ease of distribution to podiatry laboratories
- Produced and sold in dried precut rectangular plates in moisture-resistant bags that are ready for fabrication into orthotics
- Five standard sizes cover the full range of orthotic requirements but is also available in full sheet format (1220 mm x 910 mm). All products have a .007" film on the outside to improve durability

PRODUCT TYPE AND COMPOSITION

CFRT® (Continuous Fiber Reinforced Thermoplastic) composite with 3K/6K carbon fiber and modified Polymethylmethacrylate (acrylic) resin

TYPICAL APPLICATIONS

- Foot Supports
- Orthotics
- Preforms

SHELF LIFE

Stable indefinitely at 25°C (77°F)

TL-2100 must be kept dry, please refer to processing information.

Materials must be dried prior to heating and thermoforming. Please refer to the TPMC Processing Instructions.

TORAY CFRT® TL-2100 SHEETS AND ORTHOTIC BLANKS

Product Highlight

Size	Dimensions	
1	76.2 x 177.8 mm	3.0 x 7.0 in
3	88.9 x 190.5 mm	3.5 x 7.5 in
4	101.6 x 203.2 mm	4.0 x 8.0 in
5	101.6 x 215.9 mm	4.0 x 8.5 in
6	127 x 228.6 mm	5.0 x 9.0 in

Sizes 1 and 3 are not available in the Ultra Strength grade.

Additional sheet sizes are available on a factory special order basis only. Contact your materials distributor for further information.

TYPICAL LAMINATE PROPERTIES: THICKNESS VS. RIGIDITY

Properties	Semi-Flex *based on 0.177 cm thickness	Semi-Rigid *based on 0.228 cm thickness	Rigid *based on 0.279 cm thickness	Ultra *based on 0.292 cm thickness
Thickness (cm/in)	0.1778 cm/0.070 in	0.2286 cm/0.090 in	0.2794 cm/0.110 in	0.2921 cm/0.115 in
Inner core (mm/in)	0.33 mm/0.013 in	0.64 mm/0.025 in	1.27 mm/0.050 in	1.27 mm/0.050 in
Carbon fiber tow size	3K x 6K	3K x 6K	3K x 6K	6K x 3K
Rigidity*	495 N-cm	835 N-cm	1600 N-cm	2075 N-cm
Flex load (kg/lbs)*	75 kg/165 lbs	127 kg/280 lbs	159 kg/350 lbs	186 kg/410 lbs
Modulus (GPa)*	11.0 GPa	8.6 GPa	8.2 GPa	9.5 GPa
Strength (MPa)*	275 MPa	230 MPa	240 MPa	235 MPa
Polypro replacement	1/8–3/16″	3/16–1/4″	1/4″ +	1/4″ +
	3.2–4.8 mm	4.8–6.4 mm	6.4 mm +	6.45 mm +

Since 1986, Toray PMC's CFRT® TL-2100 has over 30 years of proven performance and is the premium graphite orthotic material on the market. In celebration of TL's continued success, Toray PMC will be launching this material in two NEW designs on January 2020: TL-2100 Pre-fabs and TL-2100 Carbon Foot Supports (CFS).

TORAY CFRT® TL-2100 PREFAB

Product Highlight

GRADES:

SEMI-RIGID

INTRODUCTION:

Our carbon composite preforms are made from CFRT® TL-2100 material. TL-2100 is Toray PMC's premium orthotic material and is now celebrating over 30 years of proven performance.

KEY BENEFITS:

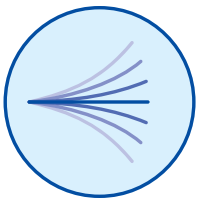
- Thin for better fit and unmatched comfort
- Lightweight support and stability
- Functional control
- Resiliency for fast response
- Thermoplastic, truly heat adjustable

TORAY CFRT® TL-2100 PREFAB

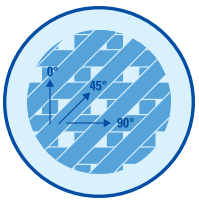
Product Highlight

Men's		Women's	
Semi-Rigid Item #	**Sizes**	**Semi-Rigid Item #**	**Sizes**
1145238	M6 / MW-38	1155235	W4 / LS-35
1145239	M7 / MW-39	1155236	W5 / LS-36
1145240	M8 / MW-40	1155237	W6 / LS-37
1145241	M9 / MW-41	1155238	W7 / LS-38
1145242	M10 / MW-42	1155239	W8 / LS-39
1145244	M11 / MW-44	1155240	W9 / LS-40
1145245	M12 / MW-45	1155241	W10 / LS-41
1145247	M13 / MW-47	1155242	W11 / LS-42

Lightweight



Resilient



Engineered Reinforced Orientation

TORAY CFRT® GRAPHITE FOOT SUPPORT (GFS)

Product Highlight

These ultra-thin graphite foot supports (GFS) fit into most footwear and are biomechanically engineered from TPMC's proprietary CFRT® TL-2100 material. TL-2100 is our premium orthotic material that has revolutionized foot care for over 30 years.

FEATURES

- Provides arch support and stability
- Absorbs impact forces as you walk
- Resilient, springs back with each step
- Maintains its original shape
- Durable to ensure comfort for years
- Ultra thin, only 0.035 in/0.9 mm

GFS's are designed to fit most dress and casual style footwear. The GFS High Heel style is designed specifically for shoes with heel heights of 1¾" up to 3½".

Men's High-Heel Women's

TORAY CFRT® GRAPHITE FOOT SUPPORT (GFS)

Product Highlight

Men's		Women's		High-Heel	
Item Number	**Sizes**	**Item Number**	**Sizes**	**Item Number**	**Sizes**
F707012533S	M7-7T	F707022571S	W5-5T	F707032571S	HH W5-5T
F707012535S	M8-8T	F707022573S	W6-6T	F707032573S	HH W6-6T
F707012537S	M9-9T	F707022575S	W7-7T	F707032575S	HH W7-7T
F707012540S	M10-10T	F707022577S	W8-8T	F707032577S	HH W8-8T
F707012542S	M11-11T	F707022579S	W9-9T	F707032579S	HH W9-9T
F707012544S	M12-12T	F707022581S	W10-10T	F707032581S	HH W10-10T

PRODUCT HISTORY AND MATERIALS

Medical Design

- This product was designed and developed by a leading podiatrist with over 20 years of experience in sport medicine.
- Clinically shown to accommodate the widest span of foot types

100% Carbon Fiber Reinforced Composite

- Graphite carbon is the material of choice for high performance sports equipment due to its high strength, light weight, and super resilient mechanical properties.
- Same material construction used for premium prescription orthotics by leading U.S. podiatry labs.
- Highly resilient material will maintain its performance over the life of the device.

TORAY CFRT® TL-SILVER SHEETS AND ORTHOTIC BLANKS

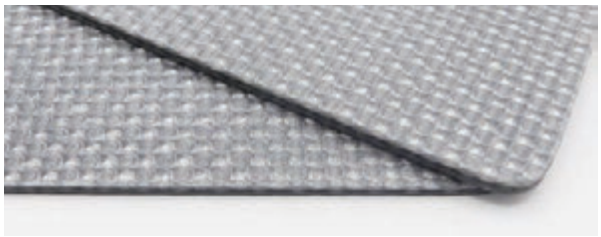
Product Highlight

DESCRIPTION

Toray PMC CFRT® TL-Silver, is a continuos fiber reinforced thermoplastic composite. It blends the benefits of a thermoplastic polymer matrix with woven glass fibers for enhanced performance. TL-Silver is available in two material grades (Semi-Rigid and Rigid) and in five standard sizes to cover the full range of orthotic requirements.

FEATURES

- Low-cost premium orthotic materials
- Excellent orthosis comfort
- Functional biomechanic control
- Excellent formability for a deep cut heel
- Available color: Silver



PRODUCT TYPE AND COMPOSITION

SEMI-RIGID
Glass fiber content: 39%
Modified PMMA thermoplastic resin: 61%
RIGID
Glass fiber content: 31%
Modified PMMA thermoplastic resin: 69%
(Note: Percentages are by volume and are nominal values)

MATERIAL PROPERTIES

	SEMI-RIGID	RIGID
Specific Gravity	1.4	1.4
Thickness	2.35 ± 0.2 mm	2.80 ± 0.2 mm
Standard Colors	Silver	
Size	Cut to customer specifications from sheet of 91 x 122 cm (36 x 48 inches)	
Forming Temperature	195°C to 200°C (383°F–392°F)	
Bonding Temperature	55°C to 60°C (131°F–140°F)	

TYPICAL APPLICATIONS

- Foot Supports
- Orthotics
- Preforms

SHELF LIFE

Stable indefinitely at 25°C (77°F)

Materials must be dried prior to heating and thermoforming. Please refer to the TPMC Processing Instructions.

MECHANICAL PROPERTIES

Properties	Method	Results	
		Semi-Rigid*	Rigid**
Flexural Rigidity	ASTM D790-10	~ 1130 N-cm	~ 1450 N-cm
Flexural Modulus	ASTM D790-10	~ 8.5 GPa	~ 7.5 GPa
Flexural Strength	ASTM D790-10	> 240 MPa	> 250 MPa

**Tested at 2.49 mm thickness*
***Tested at 2.78 mm thickness*

TORAY CFRT® TL-SILVER PREFABS

Product Highlight

DESCRIPTION

Toray CFRT® TL-Silver Prefabs are avaialble in two grades: Rigid and Semi-Rigid. The parts are cut and formed using our standard prefab design. The material used is our standard CFRT® TL-Silver sheet material which blends the benefits of a thermoplastic polymer matrix with woven glass fibers for enhanced performance.

FEATURES

- 5 standard sizes, 2 grade options
- Excellent orthosis comfort
- Functional biomechanic control
- Plain weave fiberglass and acrylic construction with inner core
- Lower cost premium orthotic material
- Easy to fit and finish

Sizing	Length
1	76.2 mm x 177.8 mm
3	88.9 mm x 190.5 mm
4	101.6 mm x 203.2 mm
5	101.6 mm x 215.9 mm
6	127 mm x 228.6 mm

PROCESSING INFORMATION

The TL-Silver can be processed with conventional fabrication equipment, and the recommended heating conditions for all forumlations is 3-5 minutes in a convection oven, pre-heated to 380-400°F

TORAY CFRT® TL-6000 SHEETS

Product Highlight

DESCRIPTION

Toray PMC CFRT® (TL-6000) is a reinforced thermoplastic composite that blends the benefits of a thermoplastic polymer matrix with woven carbon fibers for enhanced performance. Within the product range, 2 layer (M1, 2L), 3 layer (3L), or 4 layer (4L) products are available. All are thin, lightweight, and resilient. This material can be drilled, ground, polished and adjusted after being formed with a heated gun. TL-6000 has a smooth high-gloss finish and transparent surface to show woven carbon fiber.

FEATURES

- High strength and stiffness
- High mechanical properties of "Thin & Light" (TL) laminates
- Carbon fiber weave shown with a high-gloss and smooth finish
- Available in multilayers
- Acrylic core option available as M1 construction

PRODUCT TYPE AND COMPOSITION

CFRT® (Continuous Fiber Reinforced Thermoplastic) composite with 12K carbon fiber and modified PMMA (acrylic) resin

TYPICAL APPLICATIONS

- Orthosis knee and ankle bracing
- Components for Prosthetics
- Other Medical applciations

SHELF LIFE

Stable indefinitely at 25°C (77°F)

Materials must be dried prior to heating and thermoforming. Please refer to the TPMC Processing Instructions.

MATERIAL PARAMETERS

Size	Cut to customer specifications from sheet of 91 x 122 cm (36 x 48 inches)
Standard Colors	Natural (Carbon)
Forming Temperature	195°C to 200°C (383°F–392°F)

TORAY CFRT® TL-6000 SHEETS

Product Highlight

PHYSICAL ATTRIBUTES

Properties	Thickness Range
TL6000 2-layer	1.98 mm–2.41 mm (0.078–0.095″)
TL6000 M1 *	2.74 mm–3.20 mm (0.108–0.126″)
TL6000 3-layer	2.74 mm–3.18 mm (0.108–0.125″)
TL6000 4-layer	3.42 mm–3.71 mm (0.135–0.146″)

*this construction is with a 0.045″ core

PROPERTIES: METHOD ASTM D790-10

Properties	2 Layer *based upon 2.15 mm″ thickness	M 1 *based upon 3.02 mm thickness	3 Layer *based upon 2.92 mm thickness	4 Layer ″based upon 3.42 mm thickness
Specific Gravity (g/cc)	1.4 g/cc	1.37 g/cc	1.42 g/cc	1.42 g/cc
Flexural Rigidity	1410 N-cm	6700 N-cm	3500 N-cm	9935 N-cm
Flexural Modulus	16.5 GPa	29.0 GPa	15.5 GPa	28.4 GPa
Flexural Strength	310 MPa	266 MPa	350 MPa	365 MPa

TORAY CFRT® TL-6000:

Orthosis knee brace application example.

TORAY CFRT® XT SHEETS AND ORTHOTIC BLANKS

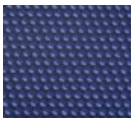
Product Highlight

DESCRIPTION

Toray PMC CFRT® XT-Orthotics are lightweight, high strength laminates that are available in several rigidity types ranging from Ease Flex to Ultra Rigid.

FEATURES

- Thin, durable material for custom orthotics for use in broad and demanding applications, (i.e. dress shoes, athletic applications)
- 6 XT grades for ultimate design control
- Easy to mold and finish, requiring no special handling
- Value/performance leader
- High performance - yet economical


Baytek Blue


Ice


Silver Dot


Seawolf

TYPICAL LAMINATE PROPERTIES: THICKNESS VS. RIGIDITY

Property	Ease-Flex*	Semi-Flex**	Semi-Rigid***	Medium-Rigid****
Thickness	1.5–1.75 mm	1.6–1.8 mm	1.85–2.0 mm	2.1–2.4 mm
Rigidity	85 N-cm*	265 N-cm*	600 N-cm*	724 N-cm*
Flexural Modulus	3.0 GPa*	9.0 GPa*	6.7 GPa*	7.3 GPa*
Time Grid Minutes at 200°C	3.0	3.5	4.0	4.5

**Based upon 1.6 mm thickness*
***Based upon 1.7 mm thickness*
****Based upon 1.95 mm thickness*
*****Based upon 2.2 mm thickness*

Property	Rigid*	Ultra-Rigid**
Thickness	2.4–2.65 mm	2.85–3.2 mm
Rigidity	920 C-nm*	1350 C-nm*
Flexural Modulus	5.3 GPa*	5.3 GPa*
Time Grid Minutes at 200°C	4.5	5.0

**Based upon 2.6 mm thickness*
***Based upon 3.0 mm thickness*

TORAY CFRT® XT SHEETS AND ORTHOTIC BLANKS

Product Highlight

PRODUCT TYPE AND COMPOSITION

Toray PMC CFRT® (Continuous Fiber Reinforced Thermoplastic) Glass Fiber Polypropylene Thermoplastic Biaxial Laminate

TYPICAL APPLICATIONS

› Orthotics

AVAILABLE SIZES

cm	inches
8.9 x 19.1	3.5 x 7.5
10.2 x 20.3	4 x 8
12.7 x 22.9	5 x 9
61 x 91.4	24 x 36
91.4 x 122	36 x 48

PERFORMANCE

- Composite structure for thinness and high strength
- Unique resin designed for high resistance to cracking, impact, and fatigue
- Superior recoil and spring characteristics
- Deep heel cups and directional rigidity for greater foot support and control
- Can be reheated and remolded

FABRICATION

Easy to mold - allows deep heel cups, can be reheated and remolded, indefinite shelf life, no special storage conditions, easy to machine and finish, post adjustment with heat gun.

Equipment required: oven, vacuum former, mold cast, release liner (Teflon), gloves

1. Set the panel on release liner and place in oven at 200°C (400°F) for 3-5 minutes (see time grid)
2. Place the softened panel on mold.
3. Promptly apply vacuum and close the rubber membrane.
4. For the deep arches, massage out any wrinkles by hand.
5. After about 1 minute, remove molded insert and trim.

TORAY CFRT® XTX SHEETS AND ORTHOTIC BLANKS

Product Highlight

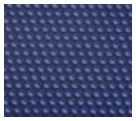
DESCRIPTION

Toray PMC CFRT® XTX-Orthotics are lightweight, high strength laminates that are available in several rigidity types ranging from Ease Flex to Ultra Rigid.

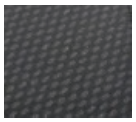
FEATURES

- Thin, durable material for custom orthotics for use in broad range of applications from dress shoes to athletics
- Four XTX grades are available: Ease Flex, Semi Rigid, Rigid, and Ultra Rigid
- Easy to mold and finish, requiring no special handling
- Value/performance leader
- High performance - yet economical

AVAILABLE PATTERNS


Baytek Blue


Ice


Silver Dot


Black


Yucatan

PRODUCT TYPE AND COMPOSITION

Toray PMC CFRT® Reinforced Carbon & Glass Fiber Polypropylene Thermoplastic Biaxial Laminate

(Continuous Fiber reinforced Thermoplastic)

SHELF LIFE

Stable indefinitely at 25°C (77°F)

No special storage conditions required.

TYPICAL APPLICATIONS

› Orthotics

TORAY CFRT® XTX SHEETS AND ORTHOTIC BLANKS

Product Highlight

PRODUCT SELECTION

XTX Code	Description	Thickness	Heating Time @ 400°-420°F (204-216°C)Oven
XTX-EF	Ease Flex	1.6mm (0.063 in)	3 minutes
XTX-SR	Semi Rigid	1.9mm (0.075 in)	4 minutes
XTX-R	Rigid	2.5mm (0.098in)	4.5 minutes
XTX-UR	Ultra Rigid	3.0mm (0.118in)	5 minutes

PERFORMANCE

- Composite structure for thinness and high strength
- Unique resin designed for high resistance to cracking, impact, and fatigue
- Superior recoil and spring characteristics
- Deep heel cups and directional rigidity for greater foot support and control
- Can be reheated and remolded

AVAILABLE SIZES

cm	inches
8.9 x 19.1	3.5 x 7.5
10.2 x 20.3	4 x 8
10.2 x 30.5	4 x 12
12.7 x 22.9	5 x 9
61 x 91.4	24 x 36
91.4 x 122	36 x 48

FABRICATION

Easy to mold - allows deep heel cups, can be reheated and remolded, indefinite shelf life, no special storage conditions, easy to machine and finish, post adjustment with heat gun.

Equipment required: oven, vacuum former, mold cast, release liner (Teflon), gloves

1. Set the panel on release liner and place in oven at 200°C (400°F) for 3-5 minutes (see time grid)
2. Place the softened panel on mold.
3. Promptly apply vacuum and close the rubber membrane.
4. For the deep arches, massage out any wrinkles by hand.
5. After about 1 minute, remove molded insert and trim.

TORAY CFRT® NRG PLATES

Product Highlight

INTRODUCTION

Toray CFRT® NRG Plates are used in medical applications to limit motion such as with Turf Toe or Hallux Rigidus and partial foot amputations. They are also used to make improvements in patients' gait and to redistribute pressures to less sensitive areas of the foot for diabetic patients. Toray CFRT® NRG plates are thermoplastic composite lamanites that are made using Toray Cetex® TC940, a semi-crystalline polyethylene terephthalate (PET) matrix resin. NRG Plates are available in Semi-Flex, Semi-Rigid, and Rigid grades and in various styles including Flat Plates, Contour Plates, and Morton Toe Plates. Standard packaging for Toray NRG plates is 10 units per pack.

FEATURES

- Uni-directional glass and carbon
- Light weight, thin, multiple layers
- High performance, yet economical
- Easy to bond using conventional adhesives.

STIFFNESS GRADES

Grade	Description	Thickness
SF	Semi Flex	0.17cm (0.07in)
SR	Semi Rigid	0.19cm (0.08in)
R	Rigid	0.22cm (0.09in)

FLAT PLATES (L Code - L3031)

Item Code	Available Grades	Description	Length	Men Sizes*		Women Sizes*	
				US	EU	US	EU
FP18	SF, SR, R	X-Small	18.0cm (7.09in)	-	-	3	-
FP21	SF, SR, R	Small	20.6cm (8.11in)	-	-	4	-
FP24	SF, SR, R	Medium	23.8cm (9.37in)	6	38	7	37½
FP26	SF, SR, R	Large	26.0cm (10.25in)	8	41	9	40
FP29	SF, SR, R	X-Large	29.0cm (11.42in)	11	44½	12	45

CONTOUR PLATES (L Code - L3031)

Item Code	Available Grades	Description	Length	Men Sizes*		Women Sizes*	
				US	EU	US	EU
CP23	SF, SR, R	Small	23.0cm (9.06in)	5	37	6	36
CP26	SF, SR, R	Medium	25.6cm (10.08in)	8	41	9	40
CP29	SF, SR, R	Large	28.3cm (11.14in)	11	44½	12	45
CP31	SF, SR, R	X-Large	30.8cm (12.12in)	13	47	14	48

MORTON TOE PLATES (L Code - L2360)

Item Code	Shape	Direction	Available Grades	Standard Length	Extended Length
MTF	Flat	-	SR, R	20.2cm (7.95in)	26.0cm (10.25in)
MTCL	Contour	Left	SR, R	20.2cm (7.95in)	26.0cm (10.25in)
MTCR	Contour	Right	SR, R	20.2cm (7.95in)	26.0cm (10.25in)

**Up to each size*

TORAY CFRT® SP 2.3 PLATES

Product Highlight

DESCRIPTION

Toray PMC CFRT® (SP 2.3) is a reinforced thermoplastic composite laminate. It blends the benefits of a thermoplastic polymer matrix with uni-directional glass and carbon fibers set in cross-ply construction for enhanced performance and design control. The SP 2.3 comes with a Seawolf Grey/Burgundy polyester coating on both sides for enhanced aesthetics.

FEATURES

- Uni-directional glass and carbon
- Light weight, thin, multiple layers
- High performance, yet economical

PRODUCT TYPE AND COMPOSITION

Glass fiber content: 30%–35%
Carbon fiber content: 22%–28%
PET content: 30%–35%
Polyester content: 3%–5%
Acrylic content: 3%–5%
(Noted: Percentages are by volume and are nominal values)

TYPICAL APPLICATIONS

- Medical Footplate

SHELF LIFE

Stable indefinitely at 25°C (77°F)

Materials must be dried prior to heating and thermoforming. Please refer to the TPMC Processing Instructions.

MATERIAL PARAMETERS

Specific Gravity	1.40 ± 0.15 (Calculated based upon material volume)
Thickness	2.2 mm–2.5 mm
Size	Cut to customer specifications from sheet of 91 x 122 cm (36 x 48 inches)
Forming Temperature	400°F for 3.0 min

SIZING

Item Code	Item Number	Length
SP 2.3 Small	F8513073601	230 mm (9.05in)
SP 2.3 Medium	F8513073606	250 mm (9.84in)
SP 2.3 Large	F8513073611	285 mm (11.22in)
SP 2.3 X-Large	F8513073611X	308 mm (12.12in)

MECHANICAL PROPERTIES

Properties	Method	Results
Flexural Rigidity	ASTM D790-10	> 1002 N-cm*
Flexural Modulus	ASTM D790-10	> 9.0 GPa*
Flexural Strength	ASTM D790-10	> 147.1 MPa*

** Based upon 2.3 mm thickness*

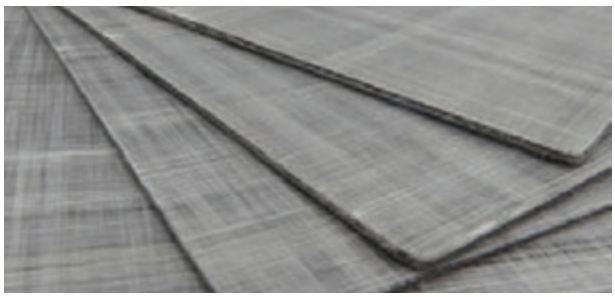
TORAY CFRT® XRP

DESCRIPTION

Toray PMC CFRT® (XRP) is a reinforced thermoplastic composite laminate that brings innovative technology to orthotic and glass fiber reinforcement with polypropylene (PP) applications. It satisfies both the workshop need for ease of fabrication and the patient need for comfort and performance. Parts and devices made from thermoplastic sheets, of polypropylene, are reinforced in strategic locations by thermobonding the XRP panel to the polypropylene part during vacuum forming or drape molding. The result is a part with increased strength and stiffness, without having to raise the basic sheet thickness. We offer XRP in four different grades.

FEATURES

- Glass fibers for maximum reinforcement
- Increased strength and stiffness of local areas
- Polypropylene matrix, to heat weld to polypropylene and copolymer materials
- Thin and lightweight
- Allows reduction of part thickness
- Easily molded to deep contours
- Can be adjusted with local heat



PRODUCT TYPE AND COMPOSITION

Glass fiber content: 55%
Polypropylene: 45%
(Noted: Percentages are by volume and are nominal values)

TYPICAL APPLICATIONS

- Braces
- Foot inserts
- Reinforcements
- Sockets

MATERIAL PARAMETERS

Available Sizes	Full Panel 91.5 x 122.0 cm (36 x 48 inches), Full & Quarter Panel 45.5 x 61 cm (18 x 24 inches)
Standard Color	Gray
Forming Temperature	200°C (400°F)

SHELF LIFE

Stable indefinitely at 25°C (77°F)
Please refer to the TPMC Processing Instructions.

Stable indefinitely at 77°F (25°C)
Please refer to the TCPC Processing Instructions.

PROPERTIES

Product Data		XRP Products/Grades			
Properties	**Units**	**110**	**112**	**114**	**116**
Thickness	mm	1.50 mm	1.78 mm	2.28 mm	3.32 mm
Rigidity	N-cm	458	580	1043	2330
Flexural Modulus	GPa	17.6	13.9	9.1	7.1

**Reinforcement panels are available in a number of grades, for general reinforcement as well as uni-directional reinforcement.*
**Approximates (based upon single test specimen)*
**Test method = ASTM D790-10*

Lightweight support to minimize fatigue and to increase comfort.

Tunable footbed plate to allow flexibility in the forefoot and biomechanical stability in the arch and heel.

Photos courtesy of the respective companies. Printed in USA.

For more information about Toray CFRT® materials for Medical applications, please visit us online and download our latest product datasheets: **www.toraypmc.com**

TPMC_Medical Catalog _v5.2.2_10192021

TORAY

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