

# FOOTWEAR

CFRT® Performance Materials Selector Guide



**GET THE MATERIAL EDGE™**

**'TORAY'**

Toray Performance Materials Corporation

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## Company Profile

Toray Performance Materials Corporation began as Medical Materials Corporation (MMC) founded in 1986. The primary market was medial foot orthotic materials. This was the beginning of the TL brand which is still the foremost premium orthotic material on the market. Later, MMC was renamed to Performance Materials Corporation (PMC) as we entered other markets (e.g., footwear, skates, etc.) and acquired Baycomp Company in 2001. TenCate acquired Performance Materials Corporation in June 2012, and was renamed TenCate Performance Composites (TCPC). In July 2018, TCPC was acquired with its parent company TenCate Advanced Composites and later named Toray Performance Materials Corporation.



### CORPORATE PHILOSOPHY:

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

### CFRT® MATERIALS:

TPMC is the leading supplier of high performance continuous fiber reinforced thermoplastic composite materials to the sporting goods, computer, construction, automotive, medical, and other markets. Our composite materials can be found in over 100 million pairs of shoes worldwide and under the feet of more than 5 million patients who require podiatric correction. Additionally, TPMC composites are used for high performance braces in the orthopedic profession. Our CFRT® composites are worn by all-star professional athletes, people who run 10k's, shoot hoops, try to break par, and climb mountains.

TPMC proprietary technology has advantages over other thermoplastics technologies in the method that the materials are produced, which leads to greater consistency and accuracy. TPMC composites have high durability with excellent damping and shock attenuation and resiliency, which results in enhanced energy return (spring) and response. TPMC composites provide superior stability and support, yet are lightweight and thin enough to minimize weight to reduce fatigue and stress.

## Locations



### PRODUCTION

#### **TPMC CORPORATE HEADQUARTERS**

1150 Calle Suerte  
Camarillo, CA 93012 USA  
Tel: 805-482-1722 Fax: 805-482-8776  
contact@toraypmc.com

### SALES OFFICE

**Contact: Laurie Calligaris**  
1150 Calle Suerte  
Camarillo, CA 93012 USA  
Tel: 805-482-1722 Fax: 805-482-8776  
contact@toraypmc.com

#### **TPMC Performance Materials (Guangzhou) Ltd.**

Contact: Leonard Lin  
Bldg. 11 #48 Hongmian Ave. Xinhua Town,  
Huadu District, Guangdong Province  
Guangzhou, China  
Tel: 011-86-20-3687-2887 ext.2992  
l.lin@toraypmc.com

### DEVELOPMENT

#### **TPMC Taiwan, R.O. Office**

Contact: Bruce Chen  
No. 760 Zhongming S. Rd., South District  
Taichung City, 402 Taiwan  
Tel: 886-4-22606718  
b.chen@toraypmc.com

- Camarillo, CA - High volume producer of TPMC CFRT® thermoplastic laminates and components.
- Guangzhou, China - A Wholly Foreign Owned Enterprise (WFOE) established to manufacture components and value-added assemblies from TPMC CFRT® Materials.

## The Material Edge™

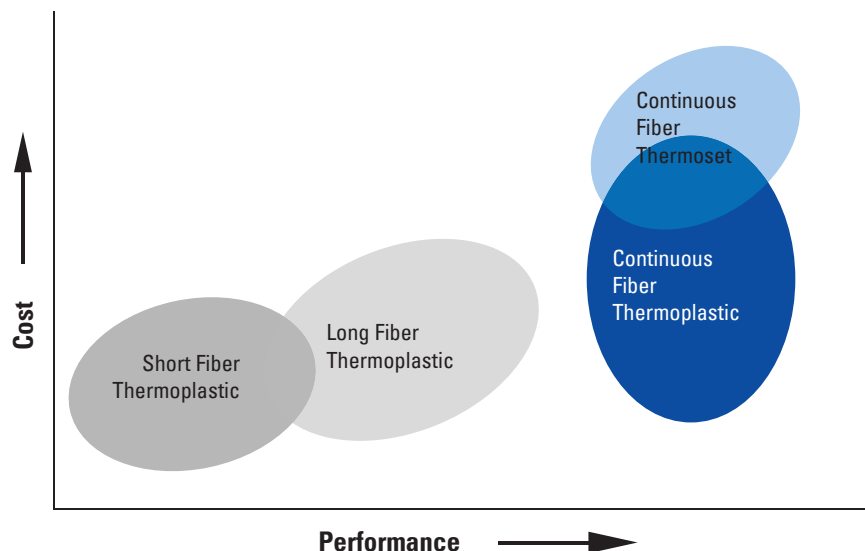
TPMC CFRT® composite materials are used to enhance footwear performance. Our materials have unique attributes and, when used strategically, can reduce the weight of footwear substantially while increasing biomechanical stability. Our materials are used in combination with other components to create footwear which is truly engineered.

The “resilience” (spring or responsiveness) effect of TPMC CFRT® composite materials means they return to their original shape through millions of cycles thus contributing to reduced foot fatigue and injury prevention.

TPMC CFRT® materials have performance and weight advantages over “chopped fiber reinforced” or “nonreinforced” injection molded materials.

The TPMC 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,” TPMC CFRT® materials provides engineered strength from one end of the component to the other.

TPMC CFRT® materials can be designed with a 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.







Our CFRT® composite materials are offered in laminate format. Our laminates are available in panels and cut parts (flat or formed). 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.

**WOVEN SERIES** Our woven series materials are offered in a variety of weave styles and fiber (carbon and glass) combinations. Each is chosen for its own unique performance, aesthetic, and economic attributes.

**CARBON FIBER** - the greatest strength-to weight option available.

The carbon fiber products are ultra-thin (~1 mm thickness), lightweight, and resilient for improved performance.

- >TL-2000: Single or multilayer of 3K carbon in a plain weave
- >TW-2000: Single or multilayer of 12K carbon in a twill weave
- >TW-2000 EB®: Multilayer of 12K carbon in a twill weave

**GLASS FIBER** - the most cost-effective woven composite.

Glass fiber products (~1 mm thickness) are the most cost-effective composite materials with all woven glass fiber reinforcement. Similar performance characteristics compared to the carbon/glass options but slightly thicker and heavier (glass weighs more than carbon fibers). The all glass fiber products are available in several weave options:

- >AG18-2L: Basket weave, all glass 2 layers
- >AG24-2L: Basket weave, all glass 2 layers
- >AG7544-2L: Plain weave 2 layers
- >TWAG: Twill weave, all glass 1 layer

**CARBON/GLASS FIBER** - the most efficient carbon product.

Carbon/glass fiber products are thin (~1 mm thickness) that blend the optimal performance, aesthetics, and cost effectiveness with glass replacing at least half of the carbon fibers. Carbon fibers are orientated 90 degrees to the glass fibers for bi-directional mechanical properties. Several fabric/weave options are available:

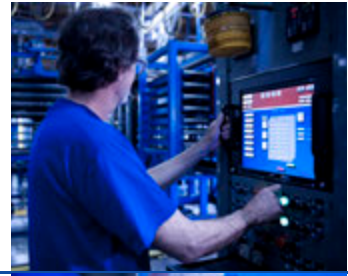
- >PW-1000: Plain weave of 12K carbon and glass
- >TW-1000: Twill weave of 12K carbon and glass
- >TW-1000 EB®: Twill weave of 12K carbon and glass
- >TW-4000: Twill weave of 12K carbon and glass
- >BW-1000: Basket weave of 12K carbon and glass
- >BW-1000 Reemay: Basket weave of 12K carbon and glass

**XTS UNI-DIRECTIONAL SERIES** XTS is a continuous fiber reinforced thermoplastic (CFRT®) composite that blends the benefits of a thermoplastic polymer matrix with uni-directional glass or carbon fibers for enhanced cost-effective performance. XTS can be a multilayer product engineered to deliver properties that will provide specific support, resiliency, and energy return.

## Sheet Manufacturing

TPMC's vertically integrated manufacturing allows for lower production costs, greater flexibility, and fast delivery. TPMC's factory is operated using computer-aided manufacturing systems. The manufacturing processes for producing TPMC CFRT® materials (continuous fiber reinforced thermoplastic) sheet 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 alloy with fiber reinforcement. The result is a synergistic material with greater strength than the two alone.





## Footwear Laminate Style

	Type	Laminate Style	Resin	Style	Thickness mm	Rigidity N-cm	Modulus GPa	Strength MPa
CARBON	Carbon	SL-2000/ SuperLam	PMMA	Plain Weave/ Twill Weave	0.25	--	--	--
	Carbon	TL-2000	PMMA	Plain Weave	~ 0.89	~ 6700	~ 29	~ 266
	Carbon	TW-2000 1L	PMMA	Twill Weave	0.70 ± 0.15	~ 47.6	~ 22.8	> 450
	Carbon	TW-2000 2L	PMMA	Twill Weave	1.27 ± 0.15	~ 450	~ 35.1	> 530
	Carbon	TW-2000 1L EB®	PMMA	Twill Weave	0.85	~ 36	~ 6000	~ 195
CARBON/GLASS	Carbon/Glass	BW-1000	PMMA	Basket Weave	1.0	> 55	> 6200	> 188
	Carbon/Glass	BW-1000 401 EB®	PMMA	Basket Weave	1.05	> 105	> 10500	> 150
	Carbon/Glass	PW-1000	PMMA	Plain Weave	0.85	> 55	> 6200	> 188
	Carbon/Glass	TW-1000	PMMA	Twill Weave	1.0	> 45	> 7445	> 148
	Carbon/Glass	TW-1000 401 EB®	PMMA	Twill Weave	1.05	< 80	> 140	> 7000
GLASS	Glass	AG-18 2L	PMMA	Plain Weave	0.95	4 tow per inch: 89 5 tow per inch: 104	4 tow per inch: 13000 5 tow per inch: 16000	4 tow per inch: 470 5 tow per inch: 604
	Glass	AG-33 1L	PMMA	Plain Weave	0.89	~ 35	~ 6800	~ 190
	Glass	AG-33 2L	PMMA	Plain Weave	1.73	~ 360	~ 12400	~ 330
	Glass	XTS-3L	ABS	Unitape	0.95	> 126	> 18	> 479
	Glass	XTS-4L	ABS	Unitape	1.25	> 118	> 116	> 398
	Glass	TWAG	PMMA	Twill Weave	0.95	> 40	> 6000	> 250
	Glass	SS-AG7544	TPU	Plain Weave	0.96	> 101	> 12750	> 247.5
	Glass	SS-AG7781	TPU	Plain Weave	0.2	--	--	--

ENVIR-Bond® (EB) is TPMC's material innovation to improve the ease of processing at the factory level and help reduce the amount of harmful solvents used in the footwear manufacturing process. EB "tie-layers" are added for injection over molding.

## Footwear Applications



**Heel Stability Plate (Lateral/Medial)** - Recommended for running shoes, the use of CFRT® materials for this component part will help to stabilize the heel during the heel strike. Adding a heel stability plate will help to minimize pronation and supination.

**Turf Plate** - Typically used in turf footwear, the turf plate is used in place of spring steel to limit the extension of the big toe. TPMC has developed a very specific material for this application. One added benefit of using CFRT® is that it reduces the amount of heat transferred from the turf to the wearer's foot.

**Spring Plate or Propulsion Plate** - An extension of the shank plate, the spring plate or propulsion plate extends into the forefoot. TPMC CFRT® materials have been extended even into the first and second metatarsal for added spring and resiliency. The plate can be engineered to give the desired balance of stiffness vs. compliance while absorbing the impact of the foot striking the ground. For example, when wings are added to the spring plate, it provides added medial/lateral control to the wearer.

**Shank Plate** - The shank plate is located under the midfoot or arch area of the foot as a support. This area of the shoe is often cutout or sculpted. TPMC CFRT® materials are used as a shank buried under the arch (typically in the midsole) or as an exposed torsional enhancement creating a "bridge" between the heel and forefoot. Both applications will reduce the weight of the footwear as typically other materials can be reduced by using the TPMC CFRT® technology. The larger the shank plate, the more biomechanical support and the lighter the footwear can be.



**Sock Liner or Insole** - As an aftermarket improvement or provided as a comfort or performance aspect of the footwear, TPMC CFRT® composite materials can be used as a sock liner or insole providing added support just under the foot. Studies have shown using TPMC CFRT® composite materials as a sock liner or insole will reduce foot fatigue, improve stability, and make the footwear more comfortable. The composite material is thin and light providing support while not taking up too much room in the shoe. The shell can also be heat adjusted for customization.

# Bonding Guidelines

Our TPMC CFRT® materials can be In-Molded, Stock-Fit, and Injection Overmolded. The following are our bonding guidelines.

Bonding requires that the surface be cleaned, but not dissolved with aggressive scrubbing or wiping, as the polymer can be removed exposing the fibers. Cleaners such as isopropyl alcohol (IPA) are preferred over aggressive solvents such as MEK. The surface of the material and adhesive layers should be free from contaminants such as mold release, oil from fingers in handling, etc. The content of aggressive solvents in primer and adhesives should be minimized where possible.

Excessive wiping, brushing, or pooling of cleaners, primers, and adhesives should be avoided.

## Priming

- Apply a thin layer of the primer with a clean brush with a light back and forth stroke.
- Heat the material with primer at 50–60°C (122–140°F) for 2–3 minutes in a convection oven.

## Adhesive Application

- Apply a thin layer of the adhesive with a clean brush with a light back and forth stroke.
- Heat the material with adhesive at 50–60°C (122–140°F) for 2–3 minutes in a convection oven.

Exposure to high temperature radiant heating elements should be avoided as the thermoplastic material can lose shape.

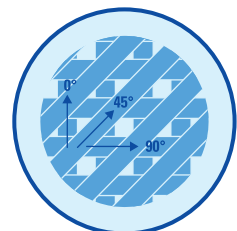
Attach the plate with adhesive to the other properly prepared component (e.g., outsole) by applying uniform pressure over the entire surface.



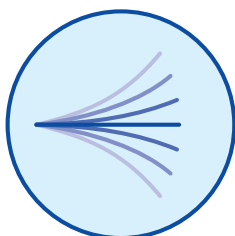
Lightweight



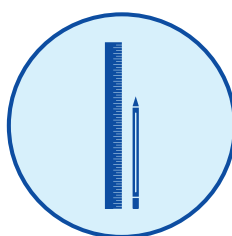
Colourfast



Engineered-reinforced Orientation



Resistant



Design Freedom



High Performance

## Designing



**Transitional/Contour Areas** - Minimum radius should be a minimum of 6 mm.

**Holes and Hole Placement** - Holes are not recommended for TPMC CFRT® applications as they disrupt the continuous fiber of the component. Holes may be incorporated into a design keeping in mind large holes, multiple holes, and holes close to the edge will weaken the composite and can cause catastrophic failure. Holes need to be addressed on a case-by-case basis.

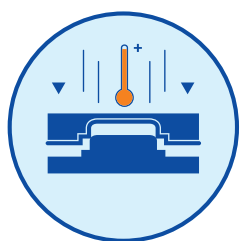
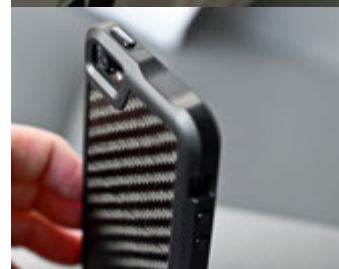
**Flex Area** - Materials placed in the flex zone will limit motion. Fiber placement and content will dictate the amount of motion limitation. For example, material running beyond the forefoot flex zone and around the forefoot will increase rigidity and limit flex.

**Arch Area** - Use of arch wrap will add stiffness to the component and, subsequently, the footwear. 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.

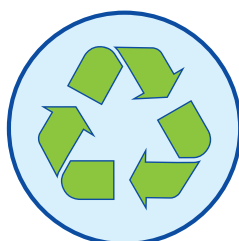
**Carbon Fiber** - Carbon fiber represents a noticeable increase in stiffness and weight reduction from fiberglass. It is also thinner than fiberglass.

**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** - TPMC CFRT® materials should be protected from objects that can cause abrasion, puncture, or fracture.



Thermoformable



Recyclable



Strong

Designs should be reviewed through TPMC Development for composite soundness and optimization. Our composite engineers are available to assist you in your application. Do not hesitate to contact us at 805-482-1722.



ISO 9001 Registered

For more information about CFRT® materials for Athletic and Performance Footwear, please visit us online and download our latest product datasheets:

[www.toraypmc.com](http://www.toraypmc.com)



iPad / iPhone / Android Apps

Photos courtesy of the respective companies. Printed in USA.

**TORAY**

Toray Performance Materials Corporation

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