

Toray Composite Materials America, Inc.

INDUSTRIAL PRODUCT SELECTOR GUIDE

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Industrial Product Selector Guide







Toray Composite Materials America, Inc. is a leading innovator and manufacturer of TORAYCA[™] carbon fiber and high quality advanced composite prepreg. Our materials are recognized worldwide as the benchmark for performance, consistency and quality, offering unique and efficient solutions for a diverse customer base.

Our industrial-grade products are available in several fiber and resin types using a wide range of fiber areal weight and resin contents. Whether the application requires high-performance composite materials for extreme environments, lightness and weight economy, or high quality surface finish, Toray offers a range of products to meet performance and budget requirements.

Carbon Fiber

TORAYCA[™] carbon fiber is globally recognized for its outstanding performance, quality, and consistency in processing. Used in several industrial, sports, and transportation and automotive applications, the full product portfolio of polyacrylonitrile (PAN)-based carbon fibers includes standard-modulus, intermediate-modulus, and high-modulus fibers with a wide range of properties.

Prepreg

Toray's range of epoxy-based thermoset resins coupled with TORAYCA[™] carbon fiber and other woven carbon or glass fibers provide high strength, durability, and environmental resistance. Our G-series prepregs maintain the high manufacturing standard of our aerospace-grade composites, optimized for use in all industries. These are designed for high flow quick cures and high-quality surface finishes, which makes it ideal for use in high-end sporting goods, automotive parts, and other industrial uses.

TORAYCA™ TYPICAL FIBER PROPERTIES

(Nominal Values)

FIBER TYPE		NUMBER OF FILAMENTS	SIZING TYPE	TENSILE STRENGTH*		TENSILE MODULUS*		ELONGATION (%)	YIELD (q/1000m)	DENSITY (g/cm ³)	STANDARD SPOOL
				(ksi)	(MPa)	(Msi)	(GPa)		()		SIZE (Kg)
STANDARD MODULUS	T300	1,000	4,5	512	3,530	33.4	230	1.5	66	1.76	1.0
		3,000	4,5						198		2.0
		6,000	4,5						396		2.0
	T400H	3,000	4	640	4,410	36.3	250	1.8	198	1.80	2.0
		6,000	4						396		2.0
	T700S	6,000	5	711	4,900	33.4	230	2.1	396	1.80	2.0
		12,000	5, 6, F						800		4.0, 6.0, 8.0
		24,000	5, 6, F						1,650		6.0, 8.0
	T700G	12,000	3, 4, 5	711	4,900	34.8	240	2.0	800	1.80	6.0
	T800H	6,000	4	796	5,490	42.7	294	1.9	223	1.81	2.0
		12,000	4,5						445		4.0
ULUS	T830H	6,000	4	774	5,340	42.7	294	1.8	223	1.81	2.0
100	T800S	12,000	5	853	5,880	42.7	294	2.0	515	1.80	4.0
IEDIATE N		24,000	1						1,030		4.0
	T1000G	12,000	4	924	6,370	42.7	294	2.2	485	1.80	4.0
ERN	T1100S	12,000	5	1,017	7,000	47.0	324	2.0	505	1.79	2.0
INT		24,000	5						1,010		2.0, 4.0
	T1100G	12,000	7	1,017	7,000	47.0	324	2.0	505	1.79	2.0
		24,000	7						1,010		2.0, 4.0
	M35J	6,000	5	654	4,510 4,700 49.8	10.8	343	1.3 1.4	225	1.75	1.0
		12,000	5	683		49.0			450		2.0
S	M40J	6,000	5	640	4,400	54.7	377	1.2	225	1.77	1.0
ULL		12,000	5						450		2.0
HIGH MODI	M46J	6,000	5	609	4,200 4,020	63.3	436	1.0	223	1.84	1.0
		12,000	5	583				0.9	445		2.0
	M55J	6,000	5	583	4,020	78.2	540	0.8	218	1.91	0.5
	M60J	3,000	5	- 554	3,820	85.3	588	0.7	103	1.93	0.25
		6,000	5						206		0.4

Manufactured in the U.S.

*Measured using the impregnated strand method. This information can be used for material selection purposes only.

** Other sizes available, refer to product data sheet.

CARBON FIBER CLASSIFICATION

TENSILE MODULUS AND TENSILE STRENGTH

Classification of carbon fibers at the highest level is usually based on the tensile modulus and tensile strength of the fiber. Toray's T series carbon fibers typically have high tensile strength and are classified by tensile modulus in standard modulus and intermediate modulus categories. The M series carbon fibers have high modulus, with the second-generation MJ series having improved tensile strength.

Standard Modulus Carbon Fiber

Standard modulus (SM) carbon fibers typically exhibit a tensile modulus of 33-34 Msi or slightly higher. These are often the most effective of the fibers as measured by tensile strength or modulus per unit cost.

Intermediate Modulus Carbon Fiber

Intermediate modulus (IM) carbon fibers exhibit a tensile modulus of about 42 Msi, with Toray's IM+ T1100 carbon fiber pushing this range up to 47 Msi. A broad range of IM fibers is available with a mix of price and performance characteristics to meet the needs of aerospace, industrial, and recreational applications.

High Modulus Carbon Fiber

Toray's portfolio of high modulus carbon fiber represents the highest modulus PAN-based carbon fibers available. They have superior tensile and compressive strengths compared to corresponding pitch-based carbon fibers.

TOW ARCHITECTURE

TORAYCA[™] carbon fibers are manufactured with various tow architectures, given by twist designation and tow size or filament count.

Twist Designation

The original carbon fibers were produced as twisted fibers, and Toray continues to make twisted and untwisted fibers. All of the fibers manufactured in the US are never-twisted, which as the name implies are never twisted even through the fiber manufacturing process. Never-twisted fibers sometimes give better strength performance compared to similar twisted or untwisted fibers.

Tow Size or Filament Count

Tow sizes vary based on the fiber type. Generally,

small tows range from 1,000 to 6,000 filaments per tow and are useful for producing woven fabrics and prepregs with tight weave patterns for good drapability. Standard tow sizes produced in the US are 12,000, and 24,000, filaments per tow.

SURFACE TREATMENT & SIZING

After carbonization, TORAYCA[™] carbon fibers are surface treated and sizing is applied to enhance the processability of the tow and ensure compatibility with various resin systems.

Surface Treatment

Surface treatment is the primary means to tune the adhesion properties of the fiber to the resin system used in the composite. This process step adds oxygen functional groups and etches the surface of the fiber. The surface treatment on the TORAYCA[™] carbon fiber varies by product type from standard to aggressive surface treatment. Proper selection depends on the resin matrix properties and desired composite performance areas, such as high tensile or compression properties.

Sizing Type

Sizing is the chemical coating applied to the fiber. The purposes of sizing are to enhance fiber processability and ensure the compatibility of the fiber to the resin matrix. Various sizing types are available with TORAYCA[™] carbon fiber as illustrated in the following table.

Resin System Compatibility for Sizing Types

SIZING TYPE	RESIN SYSTEM COMPATIBILITY*			
1	Ероху			
3	Ероху			
4	Epoxy, Phenolic, BMI			
5	General Purpose: Epoxy, Phenolic, Polyester, Vinyl Ester			
6	Ероху			
7	Ероху			
F	Vinyl Ester, Epoxy			

*Not an exhaustive list. Contact us for more information.

Sizing Amount

The processability and adhesion properties of the fiber can be further tuned based on the amount of sizing applied. Various TORAYCA[™] carbon fiber types are available with various sizing amounts. Typically, a lower sizing amount improves the spreadability of the tow, while higher sizing amount helps protect the fiber in more demanding applications.

G-SERIES PREPREG SYSTEMS

G-78

Toughened epoxy system with excellent flow properties and a flexible (250–300 °F) cure temperature. The G-78 prepregs are ideal for thin-walled tube structures that require high-bending strength, such as fishing rods, arrow shafts, and golf clubs.

G-83CM

G-83CM provides quick cure (290°F for 20 minutes) or a low temperature cure (185°F for 6 hours) with the capability to achieve class A surface finish, making it ideal for automotive applications. It works well for autoclave and fast cycle mold processes.

G-85FR

This rapid cure system (325°F for 30 minutes) was developed specifically to meet the needs of the automotive industry. It is compliant to SFI specification 56.1 flammability testing at single ply thickness and meets UL94 V-0. It is suitable for high throughput processes, offers easy handleability, and the capability to achieve a class "A" surface finish.

G-94M

G-94M is an all-around epoxy system with a flexible (250–300 °F) cure. It provides excellent mechanical properties, high-temperature resistance, controlled flow, great handling, and easy layup. These prepregs are widely used in a variety of applications including sports, outdoor, industrial, medical, and more.

RESIN NAME	FIBER FORMAT	FIBER AREAL WEIGHT (g/m²)	RESIN CONTENT (%)	Tg DRY (°F)	CURE TEMPERATURE (°F)
G-78	UD Carbon Fiber Woven and Glass Fabric	70-300	24-44	293	275
G-83CM	UD Carbon Fiber Woven and Glass Fabric	70-300	24-44	289	290
G-85FR	UD Carbon Fiber Woven , Aramid and Glass Fabric	70-665	24-44	340	325
G-94M	UD Carbon Fiber Woven and Glass Fabric	50-300	24-44	270	275

INDUSTRIAL APPLICATIONS

APPLICATION	USE	MANUFACTURING PROCESS		
COPV Tanks (CNG and CHG)	Reinforcement for high pressure tank	Filament Winding		
Wing	Blade spar caps for strength and stiffness	Pultrusion UD Fabric Followed by Resin Infusion		
Cable Core	Structural tension member	Pultrusion		
Oil & Gas	Oil field sucker rods Pipe systems	Pultrusion Thermoplastic Tapes		
Automotive	Cosmetic panels or structural parts for weight saving	Prepreg Autoclave Fabric Resin Transfer Molding SMC Compression Molding		
Marine	Structural parts for weight saving and increase payload	Prepreg Autoclave OOA Fabric Resin Transfer Molding		
Trains	Structural parts for weight saving and increase payload	Prepreg Autoclave Fabric Resin Transfer Molding Filament Winding		
Electric Vehicles	Structural parts for weight saving due to heavy battery	Prepreg Autoclave OOA Fabric Resin Transfer Molding SMC Compression Molding		
Construction	High modulus material for thinner and lighter structures High strength material for repairs and reinforcement	Fabric Infusion Hand Layup Pultrusion		
Computers	High modulus material to reduce panel thickness and weight	Prepreg Press		
Sports and Recreation	High strength and high modulus for various tube or stick	Prepreg Sheet Winding Bladder Molding		



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Revised April 2022.

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