

HIGH PERFORMANCE INDUSTRIAL

Advanced Composite Materials Selector Guide



**WE CONTRIBUTE TO SOCIETY THROUGH
INNOVATIVE IDEAS, TECHNOLOGIES, AND PRODUCTS**

'TORAY'

Toray Advanced Composites

TORAY ADVANCED COMPOSITES

Company Profile

Toray Advanced Composites is a global materials technology company supporting a diverse range of applications for engineered composites. Toray's heritage, technical capabilities, and manufacturing technology make it a leading advanced composite materials manufacturer for major industries including safety and protection, space and aerospace, infrastructure and environment, and sports and recreation. Our production sites in North America, the United Kingdom, China, and the Netherlands each offer their own specialty and expertise, providing superior overall global service.

WE MAKE YOU MOBILE

High performance industrial – Toray offers lightweight thermoset and thermoplastic options across a wide range of price and performance targets to meet customer demand for weight reduction and superior strength. Markets that benefit from our materials include:

- ▶ Medical
- ▶ Consumer electronics
- ▶ Recreational

REINVENTING THE WHEEL

Transportation – Through weight reduction, Toray materials significantly improve fuel efficiency across a broad range of transportation industries including:

- ▶ Automotive
- ▶ Interiors
- ▶ Trucks
- ▶ Rail

ENERGY. EFFICIENTLY.

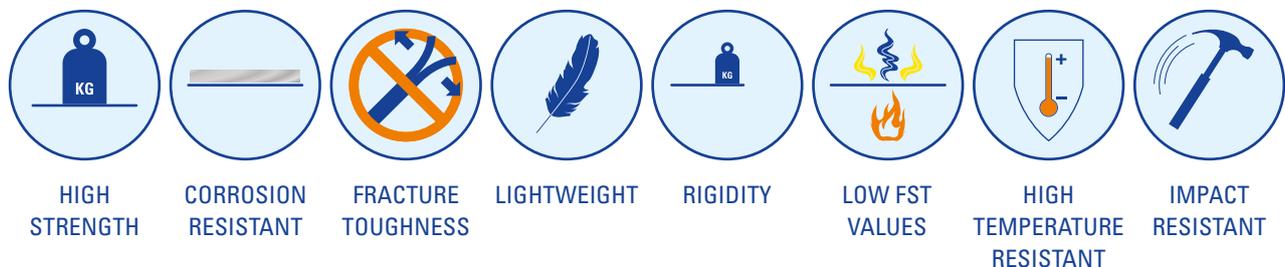
Oil and gas – High performance composites from Toray offer a lighter, safer, and more innovative alternative to traditional metals and nonreinforced plastics typically used in the oil and gas market. Applications include:

- ▶ Pressure vessels
- ▶ Piping
- ▶ Frac plugs
- ▶ Overwraps
- ▶ Gaskets
- ▶ Low dielectric enclosures
- ▶ Tubulars

THE STRENGTH OF PARTNERSHIP

Utilizing the synergy of our global production sites, Toray engages in intensive internal cooperation at technical and commercial levels with customers. We believe the success of the advanced composite market is characterized by partnership between customers, suppliers, and research institutes opening doors to new solutions and advanced applications.

Customers turn to Toray to realize the many benefits that advanced composites offer:



AmberTool® Cetex® MicroPly™

PRODUCT SOLUTIONS

- ▶ Thermoset advanced composite UD tapes and prepregs
- ▶ Thermoplastic advanced composite UD tapes, prepregs, and laminates
- ▶ Composite tooling prepregs
- ▶ Bulk molding compounds
- ▶ Compression molded parts
- ▶ Film adhesives and syntactics
- ▶ Honeycomb core

Whatever your composite material needs, Toray offers the right solution at the best value.

MARKET APPLICATIONS

- ▶ High performance automotive
- ▶ Formula 1 and motorsport
- ▶ Oil and gas
- ▶ Consumer electronics
- ▶ Medical
- ▶ Recreational
- ▶ Aerospace



LEARN MORE ABOUT THE USE OF OUR PRODUCTS IN AEROSPACE

Please visit our website for a copy of our Aerospace Advanced Composites Materials Selector Guide at www.toraytac.com/resources



Request a print copy of our technical and/or processing guides at www.toraytac.com/processing-guides



- Thermosets:
- ▶ **Toray Guide to Composites—Volume One**
 - ▶ **Toray AmberTool® Tooling Prepreg Processing Guide**



- Thermoplastics:
- ▶ **Toray Cetex® Engineering Guide for Interiors—Thermoplastic Composites**
 - ▶ **Toray Cetex® Stamp Forming Processing Guide—Thermoplastic UD Tapes**

ADVANCED & PERFORMANCE COMPOSITE PRODUCTS

High Performance Industrial Applications

HIGH PERFORMANCE AUTOMOTIVE

The automotive industry demands high-volume manufacturing and weight reduction when considering materials. Thermoplastic composite materials' rapid stamping processes make them ideal for high-volume automotive needs. Compared to injection molded and metallic parts, continuous fiber reinforced materials offer equivalent strength and stiffness with significant weight reductions.

Toray cost-saving rapid-cure, out-of-autoclave thermoset prepregs are ideally suited for exterior body panels and structural elements, while Toray Cetex® thermoplastics are ideal for impact beams, underbody panels, automotive seats, and pedals. Our materials also work in a variety of manufacturing processes, including continuous compression molding, automated tape placement, thermoforming, injection overmolding, and stamping.

OIL AND GAS

Downtime reduction and improved cycle time are critical in an industry where every minute counts. Toray corrosion resistant composite materials help reduce downtime while rapid assembly methods and utilizing spoolable pipe and lighter structures reduce infrastructure costs associated with pipeline component replacement. Toray products offer the combination of weight reduction with improved corrosion resistance, high strength, and stiffness.

Popular oil and gas applications include:

- ▶ Wrapped pipe and tubing for increased strength, weight reduction, and corrosion resistance
- ▶ Molded frac spheres
- ▶ Electrically pure dielectric structures and enclosures for down hole inspection and monitoring
- ▶ Carbon fiber reinforced tethers
- ▶ Composite pressure cylinders
- ▶ Drill plugs



OTHER APPLICATIONS

Consumer electronics - Toray offers innovative, lightweight, highly durable, and visually unique solutions for next generation electronics, such as smartphones and tablets. Through our facilities in North America, Europe, and Asia, we support the needs of turnkey manufacturing on a global scale.

Recreational - The unique high-strength, high-stiffness, and lightweight properties of composites make them valuable across a broad range of markets. Today, composites are used for the production of golf club shafts, tennis rackets, fishing rods, bicycles, boat paddles, bats, hockey sticks, and a variety of other sports equipment. Toray CFRT® thermoplastic composites can be found in applications from high-end athletic footwear to hockey skate base plates, providing stability with performance-enhancing lightweight and comfort.



Medical - Dedicated to continual investment in product development, Toray Advanced Composites, offers a portfolio of thermoset and thermoplastic materials developed specifically for medical applications, including X-ray couches, tables and mammography plates, MRI and C-scanner components, surgical target devices and tools, prosthetics, orthotics, walking aids, and wheelchairs.



THERMOSET COMPOSITES

Toray thermoset composites utilize both film impregnation and direct impregnation, controlling resin content as well as the degree of impregnation to meet unique handling and processing requirements for each customer. We work with industry-standard carbon, glass, and aramid fibers in UD, woven, and multi-axial (NCF) reinforcements, including visual quality standard carbon reinforcements. We offer a wide variety of proprietary resin systems ranging from toughened epoxies to high temperature cyanate esters and BMIs.

LOW TEMPERATURE CURING THERMOSET PREPREGS

	RESIN	T _g (ONSET)	CURE TIME AND TEMPERATURE	KEY PRODUCT CHARACTERISTICS
E650	Epoxy	121°C (250°F)	3.5 hours at 70°C (158°F)	<ul style="list-style-type: none"> ▶ Medium tack level, easier lamination ▶ 5 days out life

LOW TO MID TEMPERATURE CURING THERMOSET PREPREGS

	RESIN	T _g (ONSET)	CURE TIME AND TEMPERATURE	KEY PRODUCT CHARACTERISTICS
RS-1	Epoxy	107°C (225°F)	90 minutes at 93°C (200°F)	<ul style="list-style-type: none"> ▶ Low cure temperature curing epoxy ▶ 21 days out life
8020 Rapi-Ply	Epoxy	111°C (232°F)	5.5 hours at 80°C (176°F)	<ul style="list-style-type: none"> ▶ Outstanding vacuum-bag-only (out-of-autoclave) processing capability. No debulking required ▶ Bi-layer form facilitates fast lay-up ▶ Significantly reduced lay-up times (up to 75%) compared with traditional prepreg routes ▶ Flexible low to medium cure schedules 70–130°C (158–266°F) ▶ 7 days out life
8020	Epoxy	121°C (250°F)	5.5 hours at 80°C (176°F)	<ul style="list-style-type: none"> ▶ Flexible cure schedules 70–130°C (158–266°F) ▶ Post curable for higher T_g applications
8020-FR	FR Epoxy	121°C (250°F)	5.5 hours at 80°C (176°F)	<ul style="list-style-type: none"> ▶ 8020-FR is fire resistant under FAR 25.853 Appendix F - vertical burn material test criteria (i) ▶ 30 days out life at ambient temperature with good adhesive properties for honeycomb core



THERMOSET COMPOSITES

MID TEMPERATURE CURING THERMOSET PREPREGS

	RESIN	T _g (ONSET)	CURE TIME AND TEMPERATURE	KEY PRODUCT CHARACTERISTICS
E726	Modified Epoxy	105°C (221°F)	60 minutes at 120°C (248°F)	<ul style="list-style-type: none"> ▶ Controlled flow ▶ Good surface finish ▶ 60 days out life
E720	Epoxy	110°C (230°F)	60 minutes at 120°C (248°F)	<ul style="list-style-type: none"> ▶ Honeycomb bondable
E745	Epoxy	118°C (244°F)	60 minutes at 135°C (275°F)	<ul style="list-style-type: none"> ▶ High toughness and impact properties
E722	Modified Epoxy	120°C (248°F)	60 minutes at 120°C (248°F)	<ul style="list-style-type: none"> ▶ Excellent drapability ▶ General purpose component prepreg
E721-FR	FR Modified Epoxy	120°C (248°F)	60 minutes at 120°C (248°F)	<ul style="list-style-type: none"> ▶ Fire retardant version of E720 under FAR 25.853 Appendix F - vertical burn material test criteria (i)
BT250E-1	Epoxy	125°C (257°F)	60 minutes at 121°C (250°F)	<ul style="list-style-type: none"> ▶ Excellent overall system with moderate toughness for impact resistance
E731	Epoxy	140°C (284°F)	60 minutes at 125°C (257°F)	<ul style="list-style-type: none"> ▶ High cosmetic clarity for automotive components e.g., door panels, center console, dashboard
TC250	Epoxy	140°C (285°F) or 180°C (356°F) with post cure	60 minutes at 88°C (190°F) followed by 2 hours at 130°C (265°F) Optional post cure of 60 minutes at 177°C (350°F)	<ul style="list-style-type: none"> ▶ Long out time with excellent toughness for impact resistance ▶ Has the ability to be post cured for higher temperature performance
E750	Epoxy	148°C (298°F)	60 minutes at 135°C (275°F)	<ul style="list-style-type: none"> ▶ Variable temperature cure, starting at 80°C (176°F)
E732	Epoxy	170°C (338°F)	4 minutes at 160°C (320°F)	<ul style="list-style-type: none"> ▶ Hot-in hot-out press processing ▶ Short cure cycles between 120°C (248°F) to 160°C (320°F)
E760	Epoxy	204°C (399°F)	2 hours at 180°C (356°F)	<ul style="list-style-type: none"> ▶ High temperature resistance and high-mechanical performance
TC346 NEW	Epoxy	221°C (430°F)	2 hours at 180°C (356°F), followed by 200°C (392°F) post cure	<ul style="list-style-type: none"> ▶ Structural values retained at high temperatures ▶ High temperature resistance

HIGH SERVICE TEMPERATURE THERMOSET

	RESIN	T _g (ONSET)	CURE TIME AND TEMPERATURE	KEY PRODUCT CHARACTERISTICS
TC420	Cyanate Ester	177°C (350°F) or 348°C (658°F) with post cure	3 hours at 177°C (350°F) Optional post cure of 260°C (500°F)	<ul style="list-style-type: none"> ▶ Toray's highest temperature cyanate ester ▶ Epoxy like processing with T_g and performance of a BMI ▶ Excellent thermal stability, good resistance to microcracking
RS-8HT	BMI	203°C (397°F) or 285°C (545°F) with post cure	2 hours at 204°C (400°F), followed by post cure of 2 hours at 300°C (572°F)	<ul style="list-style-type: none"> ▶ Thermal stability under high temperatures ▶ Moderate toughness with good moisture resistance ▶ Available in RTM resin form
C740	Cyanate Ester	325°C (617°F)	2 hours at 135°C (275°F), post cure of 2 hours at 280°C (536°F)	<ul style="list-style-type: none"> ▶ Excellent high temperature capabilities for pipework and ducting applications ▶ Features long out life for larger parts
C640	Cyanate Ester	335°C (635°F)	10 hours at 80°C (176°F), post cure of 2 hours at 300°C (572°F)	<ul style="list-style-type: none"> ▶ Variable cure temperatures 70–135°C (158–275°F) ▶ Postcurable for high T_g ▶ High temperature resistance for applications such as brake ducts

TORAY AMBERTOOL® COMPOSITE TOOLING SOLUTIONS

Tooling Prepregs

AmberTool®

The Toray AmberTool® series of epoxy tooling prepregs have become the trusted benchmark products across the composites industry for over 20 years. They have an excellent reputation for reliability and deliver a cosmetic surface finish.

Toray AmberTool® tooling prepregs cure at low temperatures to allow the production of high-quality composite tooling from low-cost master patterns. Users can easily fabricate complex tool shapes. Toray AmberTool® tooling prepregs have excellent tack, drape, and handling characteristics.

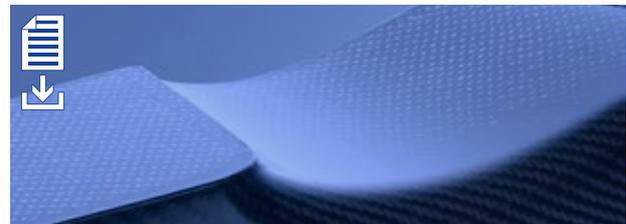
Toray prepregs are available in a range of reinforcements, although glass and carbon are most common. If required, we can also offer these in roll form or precut kits, without any impact on product out life, and multi-ply formats to reduce lay-up time and improve tool build efficiencies.

Alongside our composite materials, we offer training, design, and technical support to support you with your next tooling project.



LEARN MORE ABOUT THE USE OF OUR TOOLING PRODUCTS

Find this processing guide, case study, and more at www.toraytac.com/tooling



Toray AmberTool® Tooling Prepreg Processing Guide

Documents proven processing guidelines



Cure Capable Mandrel for Aerospace Structures

Featured products: ▶ **Toray AmberTool® HX42**

TORAY AMBERTOOL® COMPOSITE TOOLING PREPREGS

	RESIN	T _g (ONSET)*1	MIN CURE TEMP	TYPICAL CURE TIME AND TEMPERATURE*2	OUT LIFE	KEY PRODUCT CHARACTERISTICS	INDUSTRIAL	MOTORSPORT	AUTOMOTIVE	ENERGY
HX32-1*3	Epoxy	162°C (323°F)	65°C (149°F)	12 hours at 70°C (158°F)	30 days	▶ Long tack life for large applications	○			○
HXR56*3 NEW	Epoxy	185°C (365°F)	40°C (104°F)	8.5 hours at 50°C (122°F)	50 hours	▶ Quasi-isotropic two-layer product for rapid lamination	○	○	○	○
HX56*3	Epoxy	185°C (365°F)	40°C (104°F)	8.5 hours at 50°C (122°F)	60 hours	▶ Improved handleability	○	○	○	○
HX50*3	Epoxy	190°C (374°F)	40°C (104°F)	8.5 hours at 50°C (122°F)	60 hours	▶ Excellent surface finish	○	○	○	
HX42	Epoxy	200°C (392°F)	50°C (122°F)	8 hours at 60°C (140°F)	5 days	▶ Proven system for aerospace	○	○	○	
HX40	Epoxy	203°C (397°F)	50°C (122°F)	12 hours at 65°C (149°F)	8 days	▶ Large tooling applications	○			○
TC40*4	BMI	213°C (415°F)	182°C (360°F)	6 hours at 177°C (350°F)	14 days	▶ High service temperature suited to aerospace applications				

*1 after post cure *2 followed by post cure | Sourced from: *3 Europe *4 North America

TORAY CETEX® THERMOPLASTIC COMPOSITES

UD Tapes, Prepregs, and Laminates

TORAY CETEX® IS LEADING THE THERMOPLASTIC REVOLUTION

With more than 30 years invested in thermoplastic composite innovation, Toray is a proven leader in superior quality composite materials. We have expertise in amorphous and semi-crystalline thermoplastics. From PP, PA6, and PMMA all the way to PEI, PEEK, and engineered PAEK, we tailor the polymer to meet the demands of your application. Toray Cetex® thermoplastic materials are available as a broad variety of fabric-based laminates (RTLs), prepregs, and UD tapes to facilitate your manufacturing process and part design.



TORAY CETEX® THERMOPLASTIC

	RESIN	T _g / T _m ³	APPLICATION EXAMPLE	UD TAPE	PREPREG	RTL
AMORPHOUS						
TC920	Poly-Carbonate (PC)/ABS	70°C (158°F)	<ul style="list-style-type: none"> ▶ Electronic enclosures as V0 fire rated ▶ May be overmolded 			○
TC925 FST	Poly-Carbonate (PC)	153°C (307°F)	<ul style="list-style-type: none"> ▶ Good surface qualities, impact toughness ▶ Good heat resistance 		○	○
CFRT®-Series	Poly-Methyl-Meth-Acrylate (PMMA)		<ul style="list-style-type: none"> ▶ Broad range of application specific materials⁴ ▶ Engineered to meet the structural demands of volume applications including orthotics⁴ 			○ Parts
TC1000 Design	Poly-Ether-Imide (PEI)	217°C (423°F)	<ul style="list-style-type: none"> ▶ Excellent FST performance ▶ Medical applications and transportation e.g., train door applications 		○	○
SEMI-CRYSTALLINE³						
TC930	High Density Poly-Ethylene (HDPE)	38°C (100°F) T _m 120°C	<ul style="list-style-type: none"> ▶ Oil and gas applications such as pipe overwrapping as a result of its strength and toughness 	○		○ Parts
TC960	Poly-Propylene (PP)	130°C (266°F) T _m 160°C	<ul style="list-style-type: none"> ▶ Used in vehicle applications where low cost and high toughness are desired 	○		
TC910	PA6 (Nylon 6)	60°C (140°F) T _m 233°C	<ul style="list-style-type: none"> ▶ Temperature and solvent resistant ▶ Excellent toughness ▶ High-volume automotive and recreational applications ▶ Use as a preform insert for compression and overmolding to improve part performance 	○		○ Parts
TC940	Poly-Ethylene-Terephthalate (PET)	265°C (509°F) T _m 254°C	<ul style="list-style-type: none"> ▶ Good impact resistance for recreational and low cost applications 	○		
TC1100	Poly-Phenylene-Sulfide (PPS)	90°C (194°F) T _m 280°C	<ul style="list-style-type: none"> ▶ Ideal for structural applications under 93°C (200°F) service temperature ▶ Very resistant to solvents 	○	○	○
TC1200	Poly-Ether-Ether-Ketone (PEEK)	143°C (289°F) T _m 343°C	<ul style="list-style-type: none"> ▶ Very high strength, used in oil, gas, and structural applications ▶ Good heat resistance to 121°C (250°F) and above depending upon load 	○	○	○
TC1225	Engineered Poly-Aryl-Ether-Ketone (PAEK)	147°C (297°F) T _m 305°C	<ul style="list-style-type: none"> ▶ Suited for overmolding ▶ Excellent mechanical performance ▶ Oil and gas, and medical applications 	○	○	○

³ Melting point is only shown for semi-crystalline (PAEK family) thermoplastic products.

⁴ For further information, please refer to Toray Performance Materials Corporation's Footwear CFRT® Performance Materials Selector Guide.

LIGHTWEIGHT COMPOSITES

Design, Part, and Fabrication Services

COMPRESSION MOLDED PARTS

The Toray CCS group specializes in the design, tooling, and fabrication of complex compression molded parts using chopped thermoset and thermoplastic bulk molding compounds.

Compression molding offers a common alternative to machining and hand lay-up for complex geometry components and provides high-volume production at a lower cost and lighter weight. Typical reinforcements used in CCS's compression molding process include carbon and glass chopped fiber with toughened epoxy or thermoplastic resins.



BULK MOLDING COMPOUNDS

Compression molding is a highly controlled process using precise resin-infused fiber-reinforced tape made with standard, intermediate, or high-modulus fibers. Bulk molding compounds are made by chopping UD tapes into fiber lengths ranging from 12 to 50 mm (1/2" to 2"). Longer fiber lengths generally provide higher strengths, while smaller length fibers allow more complex structural details to be molded into the part. Resins can be thermoset or thermoplastic (PEEK and PPS).



BULK MOLDING COMPOUNDS

	RESIN	T _g (ONSET)	DESCRIPTION	RESIN PROPERTIES
MS-1A	Epoxy	164°C (327°F)	▶ Epoxy with high-modulus fiber	Tensile Strength - 290 MPa (42 ksi) Tensile Modulus - 131 GPa (19 Msi)
MS-1H	Epoxy	191°C (375°F)	▶ Fast cure epoxy with intermediate-modulus fiber	Tensile Strength - 255 MPa (37 ksi) Tensile Modulus - 69 GPa (10 Msi)
MS-4H	Epoxy	191°C (375°F)	▶ Fast cure epoxy with standard-modulus fiber	Tensile Strength - 303 MPa (44 ksi) Tensile Modulus - 41 GPa (6 Msi)
Toray Cetex® MC1100	PPS	90°C (194°F)	▶ Thermoplastic based with high-strength (standard) or intermediate-modulus fibers ▶ Fire retardant	Tensile Strength - 193 MPa (28 ksi) Tensile Modulus - 40.4 GPa (5.9 Msi)
Toray Cetex® MC1200	PEEK	143°C (290°F)	▶ Thermoplastic based with high-strength (standard) or intermediate-modulus fibers ▶ Fire retardant	Tensile Strength - 289 MPa (42 ksi) Tensile Modulus - 43.4 GPa (6.3 Msi)
Toray Cetex® MC1322	PEEK	162°C (324°F)	▶ Thermoplastic based with high-strength (standard) modulus fibers	Tensile Strength - 291 MPa (42 ksi) Tensile Modulus - 47 GPa (6.8 Msi)



Full sole foot plate
Toray Cetex® TW-2000 CFRT®
Carbon/PMMA



Electrical enclosure
Toray Cetex® TC910
Carbon/PA6



Backpack frame
Toray Cetex® TC940
Glass/PET UD tape



Military helmet accessory
Toray Cetex® TC910 Carbon/
PA6 UD tape

FILM ADHESIVES AND SYNTACTICS

Rolls and Sheets

The wide range of Toray MicroPly™ film adhesives are compatible with our prepregs. Film adhesives are used for bonding of honeycomb core to skin, or to bond pre-cured or post-cured laminates.

Toray MicroPly™ syntactics are epoxy films loaded with glass microspheres for low-density and high-compressive strengths. The Toray MicroPly™ range of syntactic films are ideal for sandwich core construction, edge close outs, core splices, and reinforcement areas.

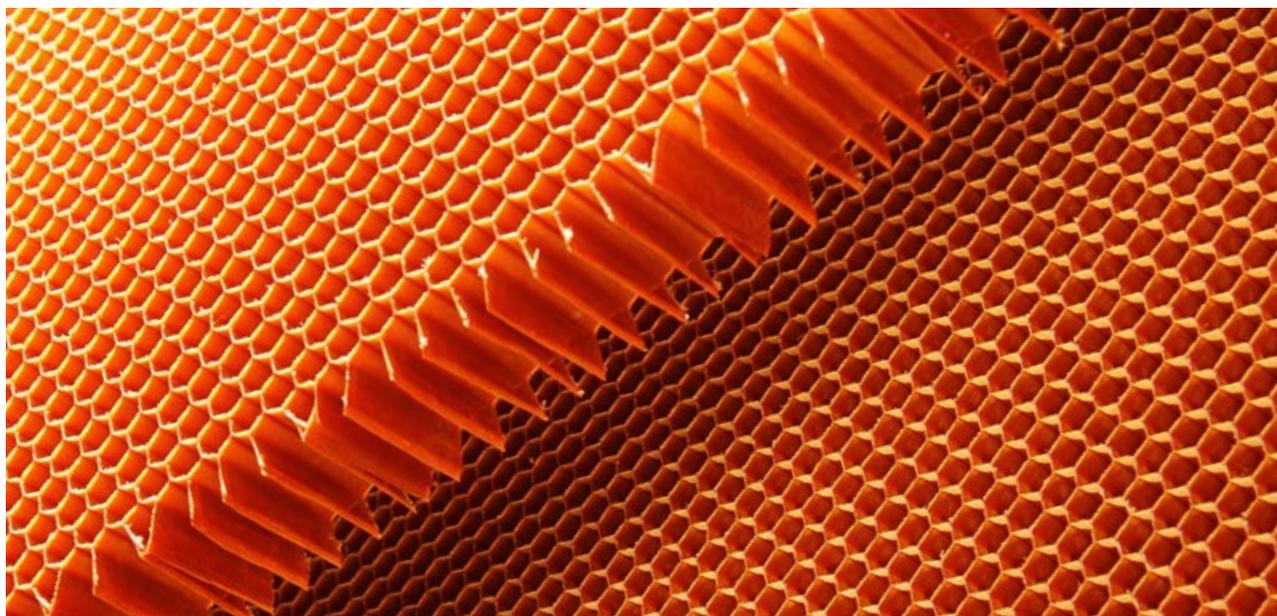


TORAY MICROPLY™ FILM ADHESIVES

	RESIN	T _g (ONSET)	CURE TEMP	KEY PRODUCT CHARACTERISTICS
EF72	Epoxy	112°C (234°F)	120°C (248°F)	▶ Structural epoxy film adhesive with 30 days out life
EF8020	Epoxy	116°C (241°F)	80°C (176°F)	▶ Wide cure temperature between 70–130°C (158–266°F) ▶ 30 days out life

TORAY MICROPLY™ SYNTACTIC CORE

	RESIN	T _g (ONSET)	CURE TEMP	KEY PRODUCT CHARACTERISTICS
SC72A	Epoxy	106°C (223°F)	120°C (248°F)	▶ Mid temperature curing, nonexpanding, syntactic film ▶ Ideal for sandwich structures under 3 mm (0.11 inches) ▶ Excellent for edge close outs
SC8020A	Epoxy	106°C (223°F)	80°C (176°F)	▶ Low density, nonexpanding ▶ Flexible cure temperatures 70–130°C (158–266°F)
ES72A-2	Epoxy	114°C (237°F)	125°C (257°F)	▶ Expanding syntactic core ▶ Varying density by tailoring cure pressure and/or volume ▶ Co-compatible with Toray E700 series



HONEYCOMB CORE AND REINFORCEMENTS

Honeycomb Core Materials and Material Comparisons

Toray Advanced Composites is one of the largest honeycomb core processors. We stock a wide variety of core materials, and can bundle core with prepreg materials for more efficient logistics and order processing. All orders are cut to customer's thickness specification and available with rapid turnaround times.

HONEYCOMB CORE⁶

	CONFIGURATIONS		KEY PRODUCT CHARACTERISTICS
Aluminum Honeycomb - Commercial Grade	1.8-3/4-25N-3003 5.2-1/4-25N-3003		<ul style="list-style-type: none"> ▶ High strength-to-weight properties at relatively low cost ▶ Easily machined and formed for applications such as air or fluid control, light collimation, heat exchangers ▶ Protects surface damage when used in laser cutting
Aluminum Honeycomb - Aerospace Grade	4.5-1/8-10N-5052 8.1-1/8-20N-5052	4.5-1/8-10N- 5056 6.1-1/8-15N- 5056 ⁷ 8.1-1/8-20N- 5056	<ul style="list-style-type: none"> ▶ High strength-to-weight properties at relatively low cost ▶ Improved mechanical properties in comparison to commercial grades ▶ Sheet size 1250 x 2500 mm except ⁷1220 x 2440 mm
Nomex [®] Honeycomb - Commercial Grade	ANC-3.2-48 3.2 mm 48 kg/m ³ ANC-4.8-32 4.8 mm 32 kg/m ³ ANC-4.8-48 4.8 mm 48 kg/m ³ ANC-4.8-48(OX) 4.8 mm 48 kg/m ³		<ul style="list-style-type: none"> ▶ Fire resistant and self-extinguishing ▶ Good thermal and electrical insulating properties ▶ High strength-to-weight ratio, easily formable to shape ▶ Sheet size 1250 x 2500 mm
Nomex [®] Honeycomb Aerospace Grade	ANA-3.2-29 3.2 mm 29 kg/m ³ ANA-3.2-48 3.2 mm 48 kg/m ³ ANA-3.2-64 3.2 mm 64 kg/m ³ ⁸ ANA-4.8-48(OX) 4.8 mm 48 kg/m ³		<ul style="list-style-type: none"> ▶ Fire resistant and self-extinguishing to FAR 25.583 ▶ High temperature strength up to 180°C (356°F) ▶ Good dielectric properties ▶ Sheet size 1250 x 2500 mm except ⁸1220 x 2440 mm
Aluminum Flex-Core [®]	5052/F80-.0013N Density 4.3 5052/F80-.0024N Density 8.0 5056 /F80-.0014N Density 4.3		<ul style="list-style-type: none"> ▶ Unique cell configurations that permit small radii of curvature without deformation of the cell walls or loss of mechanical properties ▶ For parabolic, spherical, and cylindrical shapes ▶ Sheet size 915 x 1220 mm

Flex-Core[®] is a registered trademark of Hexcel. Nomex[®] is a registered trademark of E.I du Pont de Nemours and Company.
⁶ Offered from Langley Mill, UK. Additional grades can be sourced upon request, subject to minimum order quantities and extended lead times.

MATERIAL COMPARISONS

MATERIALS VS. REINFORCEMENTS	FILAMENT COUNT	TENSILE STRENGTH	TENSILE MODULUS	DENSITY g/cc
Steel	N/A	400 MPa (58 ksi)	200 GPa (29 Msi)	7.8
Aluminum	N/A	483 MPa (70 ksi)	69 GPa (10 Msi)	2.8
E-Glass	N/A	2000 MPa (290 ksi)	72 GPa (10 Msi)	2.6
High-Strength Carbon	3K, 6K, 12K (also 18K, 24K, 48K)	3447–4826 MPa (500–700 ksi)	230–245 GPa (33–36 Msi)	1.8
Intermediate-Modulus Carbon	6K, 12K	~5516 MPa (~800 ksi)	275–304 GPa (40–44 Msi)	1.9
High-Modulus Carbon	6K, 12K	~3965 MPa (~575 ksi)	> 340 GPa (> 49 Msi)	1.9

Toray Advanced Composites works with high-strength, intermediate, and high-modulus carbon fibers in addition to glass and aramid fibers in UD, woven, and multi-axial (NCF) reinforcements. Both PAN and pitch-based carbon fibers are available.

LOCATIONS AND CAPABILITIES

SOLUTIONS

- Thermoplastic composites
- Thermoplastic laminates

- Thermoset composites
- Carbon-free manufacturing

- Parts manufacture
- Sales office

CERTIFICATIONS

- ISO 9001:2015
- AS9100D

- ISO 14001:2015
- ISO 45001:2018

Fairfield - California, United States

- ● ● ● ● ■ ■ ■ ■ ■

Morgan Hill - California, United States

- ● ● ● ● ■ ■ ■ ■ ■

Camarillo - California, United States

- ● ● ● ● ■ ■ ■ ■ ■

Nottingham, United Kingdom

- ● ● ● ● ■ ■ ■ ■ ■

Nijverdal, The Netherlands

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Toulouse, France

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Guangzhou, China

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Taichung, Taiwan

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TORAY ADVANCED COMPOSITES

Amber Drive, Langley Mill
Nottingham, NG16 4BE, UK
Tel: +44 (0)1773 530899
explore@toraytac-europe.com

TORAY PERFORMANCE MATERIALS CORP.

1150 Calle Suerte
Camarillo, CA 93012, USA
Tel: +1 805 482 1722
contact@torayPMC.com

TORAY ADVANCED COMPOSITES

2450 Cordelia Road
Fairfield, CA 94534, USA
Tel: +1 707 359 3400
explore@toraytac-usa.com

For more product information such as product data sheets, case studies, or technical papers, please use the following resources:

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