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

<table>
<thead>
<tr>
<th>RESIN</th>
<th>T_g (ONSET)</th>
<th>CURE TIME AND TEMPERATURE</th>
<th>KEY PRODUCT CHARACTERISTICS</th>
</tr>
</thead>
</table>
| E650  | Epoxy       | 121°C (250°F) 3.5 hours at 70°C (158°F) | ➤ Medium tack level, easier lamination  
➤ 5 days out life |

**LOW TO MID TEMPERATURE CURING THERMOSET PREPREGS**

<table>
<thead>
<tr>
<th>RESIN</th>
<th>T_g (ONSET)</th>
<th>CURE TIME AND TEMPERATURE</th>
<th>KEY PRODUCT CHARACTERISTICS</th>
</tr>
</thead>
</table>
| RS-1  | Epoxy       | 107°C (225°F) 90 minutes at 93°C (200°F) | ➤ 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) | ➤ 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) | ➤ 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) | ➤ 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 |
## MID TEMPERATURE CURING THERMOSET PREPREGS

<table>
<thead>
<tr>
<th>Resin</th>
<th>$T_g$ (ONSET)</th>
<th>Cure Time and Temperature</th>
<th>Key Product Characteristics</th>
</tr>
</thead>
</table>
| **E726** Modified Epoxy | 105°C (221°F) | 60 minutes at 120°C (248°F) | ▶ Controlled flow  
▶ Good surface finish  
▶ 60 days out life |
| **E720** Epoxy | 110°C (230°F) | 60 minutes at 120°C (248°F) | ▶ Honeycomb bondable |
| **E745** Epoxy | 118°C (244°F) | 60 minutes at 135°C (275°F) | ▶ High toughness and impact properties |
| **E722** Modified Epoxy | 120°C (248°F) | 60 minutes at 120°C (248°F) | ▶ Excellent drapability  
▶ General purpose component prepreg |
| **E721-FR** FR Modified Epoxy | 120°C (248°F) | 60 minutes at 120°C (248°F) | ▶ 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) | ▶ Excellent overall system with moderate toughness for impact resistance |
| **E731** Epoxy | 140°C (284°F) | 60 minutes at 125°C (257°F) | ▶ 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) | ▶ 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) | ▶ Variable temperature cure, starting at 80°C (176°F) |
| **E732** Epoxy | 170°C (338°F) | 4 minutes at 160°C (320°F) | ▶ 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) | ▶ High temperature resistance and high-mechanical performance |

## HIGH SERVICE TEMPERATURE THERMOSET

<table>
<thead>
<tr>
<th>Resin</th>
<th>$T_g$ (ONSET)</th>
<th>Cure Time and Temperature</th>
<th>Key Product Characteristics</th>
</tr>
</thead>
</table>
| **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) | ▶ Toray’s highest temperature cyanate ester  
▶ Epoxy like processing with $T_g$ and performance of a BMI  
▶ Excellent thermal stability, good resistance to microcracking |
| **C740** Cyanate Ester | 325°C (617°F) | 2 hours at 135°C (275°F), post cure of 2 hours at 280°C (536°F) | ▶ 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) | ▶ Variable cure temperatures 70–135°C (158–275°F)  
▶ Postcurable for high $T_g$  
▶ High temperature resistance for applications such as brake ducts |
| **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) | ▶ Thermal stability under high temperatures  
▶ Moderate toughness with good moisture resistance  
▶ Available in RTM resin form |
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.

### TORAY AMBERTOOL® COMPOSITE TOOLING PREPREGS

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

*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), preps, and UD tapes to facilitate your manufacturing process and part design.

**TORAY CETEX® THERMOPLASTIC**

<table>
<thead>
<tr>
<th>RESIN</th>
<th>$T_m / T_g$</th>
<th>APPLICATION EXAMPLE</th>
<th>UD TAPE</th>
<th>PREPREG</th>
<th>RTL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AMORPHOUS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| TC920 | Poly-Carbonate (PC)/ABS | 70°C (158°F) | ▶ Electronic enclosures as V0 fire rated  
▶ May be overmolded | | |
| TC925 FST | Poly-Carbonate (PC) | 153°C (307°F) | ▶ Good surface qualities, impact toughness  
▶ Good heat resistance | | |
| CFRT®-Series | Poly-Methyl-Meth-Acrylate (PMMA) | | ▶ Broad range of application specific materials⁴  
▶ Engineered to meet the structural demands of volume applications including orthotics⁶ | | |
| TC1000 Design | Poly-Ether-Imide (PEI) | 217°C (423°F) | ▶ Excellent FST performance  
▶ Medical applications and transportation e.g., train door applications | | |
| **SEMI-CRYSTALLINE³** | | | | | |
| TC930 | High Density Poly-Ethylene (HDPE) | 38°C (100°F) $T_m 120°C$ | ▶ Oil and gas applications such as pipe overwrapping as a result of its strength and toughness | | |
| TC960 | Poly-Propylene (PP) | 130°C (266°F) $T_m 160°C$ | ▶ Used in vehicle applications where low cost and high toughness are desired | | |
| TC910 | PA6 (Nylon 6) | 60°C (140°F) $T_m 233°C$ | ▶ 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 | | |
| TC940 | Poly-Ethylene Terephthalate (PET) | 265°C (509°F) $T_m 254°C$ | ▶ Good impact resistance for recreational and low cost applications | | |
| TC1100 | Poly-Phenylene-Sulfide (PPS) | 90°C (194°F) $T_m 280°C$ | ▶ 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) $T_m 343°C$ | ▶ 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) $T_m 305°C$ | ▶ 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’s Materials for the Consumer Footwear and Orthotics Markets 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

<table>
<thead>
<tr>
<th>RESIN</th>
<th>T&lt;sub&gt;r&lt;/sub&gt; (ONSET)</th>
<th>DESCRIPTION</th>
<th>RESIN PROPERTIES</th>
</tr>
</thead>
</table>
| MS-1A | Epoxy 184°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) |

Electrical enclosure
Toray Cetex® TW-2000 CFRT® Carbon/PMMA

Full sole foot plate
Toray Cetex® TC910 Carbon/PA6

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

Backpack frame
Toray Cetex® TC940 Glass/PET UD tape
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

<table>
<thead>
<tr>
<th>RESIN</th>
<th>TYPE</th>
<th>T₀ (ONSET)</th>
<th>CURE TEMP</th>
<th>KEY PRODUCT CHARACTERISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>EF72</td>
<td>Epoxy</td>
<td>112°C (234°F)</td>
<td>120°C (248°F)</td>
<td>Structural epoxy film adhesive with 30 days out life</td>
</tr>
<tr>
<td>EF8020</td>
<td>Epoxy</td>
<td>116°C (241°F)</td>
<td>80°C (176°F)</td>
<td>Wide cure temperature between 70–130°C (158–266°F)</td>
</tr>
</tbody>
</table>

### TORAY MICROPLY™ SYNTACTIC CORE

<table>
<thead>
<tr>
<th>RESIN</th>
<th>TYPE</th>
<th>T₀ (ONSET)</th>
<th>CURE TEMP</th>
<th>KEY PRODUCT CHARACTERISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC72A</td>
<td>Epoxy</td>
<td>106°C (223°F)</td>
<td>120°C (248°F)</td>
<td>Mid temperature curing, nonexpanding, syntactic film</td>
</tr>
<tr>
<td>SC8020A</td>
<td>Epoxy</td>
<td>106°C (223°F)</td>
<td>80°C (176°F)</td>
<td>Low density, nonexpanding</td>
</tr>
<tr>
<td>ES72A-2</td>
<td>Epoxy</td>
<td>114°C (237°F)</td>
<td>125°C (257°F)</td>
<td>Expanding syntactic core</td>
</tr>
</tbody>
</table>
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 Core

**Configurations**

<table>
<thead>
<tr>
<th>Material</th>
<th>1.8-3/4-25N-3003</th>
<th>5.2-1/4-25N-3003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum Honeycomb - Commercial Grade</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminum Honeycomb - Aerospace Grade</td>
<td>4.5-1/8-10N-5052</td>
<td>8.1-1/8-20N-5052</td>
</tr>
<tr>
<td>Nomex® Honeycomb - Commercial Grade</td>
<td>ANC-3.2-48 3.2 mm 48 kg/m³</td>
<td>ANC-4.8-48 4.8 mm 48 kg/m³</td>
</tr>
<tr>
<td>Nomex® Honeycomb Aerospace Grade</td>
<td>ANA-3.2-29 3.2 mm 29 kg/m³</td>
<td>ANA-3.2-64 3.2 mm 64 kg/m³</td>
</tr>
<tr>
<td>Aluminum Flex-Core®</td>
<td>5052/F80 .0013N Density 4.3</td>
<td>5052/F80 .0024N Density 8.0</td>
</tr>
</tbody>
</table>

**Key Product Characteristics**

- 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
- Improved mechanical properties in comparison to commercial grades
- High-strength-to-weight ratio, easily formable to shape
- Fire resistant and self-extinguishing to FAR 25.583
- Good thermal strength up to 180°C (356°F)
- High temperature strength up to 180°C (356°F)
- Good dielectric properties
- Unique cell configurations that permit small radii of curvature without deformation of the cell walls or loss of mechanical properties
- Fire resistant and self-extinguishing
- Sheet size 1250 x 2500 mm except 1220 x 2440 mm

### Material Comparisons

<table>
<thead>
<tr>
<th>Materials vs. Reinforcements</th>
<th>Filament Count</th>
<th>Tensile Strength</th>
<th>Tensile Modulus</th>
<th>Density g/cc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>N/A</td>
<td>400 MPa (58 ksi)</td>
<td>200 GPa (29 Msi)</td>
<td>7.8</td>
</tr>
<tr>
<td>Aluminum</td>
<td>N/A</td>
<td>483 MPa (70 ksi)</td>
<td>69 GPa (10 Msi)</td>
<td>2.8</td>
</tr>
<tr>
<td>E-Glass</td>
<td>N/A</td>
<td>2000 MPa (290 ksi)</td>
<td>72 GPa (10 Msi)</td>
<td>2.6</td>
</tr>
<tr>
<td>High-Strength Carbon</td>
<td>3K, 6K, 12K (also 18K, 24K, 48K)</td>
<td>3447–4826 MPa (500–700 ksi)</td>
<td>230–245 GPa (33–36 Msi)</td>
<td>1.8</td>
</tr>
<tr>
<td>Intermediate-Modulus Carbon</td>
<td>6K, 12K</td>
<td>~5516 MPa (~800 ksi)</td>
<td>275–304 GPa (40–44 Msi)</td>
<td>1.9</td>
</tr>
<tr>
<td>High-Modulus Carbon</td>
<td>6K, 12K</td>
<td>~3965 MPa (~575 ksi)</td>
<td>&gt; 340 GPa (&gt; 49 Msi)</td>
<td>1.9</td>
</tr>
</tbody>
</table>

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.