Toray TC250

Toray Advanced Composites

PRODUCT DATA SHEET

DESCRIPTION

Toray's TC250 offers an excellent balance of toughness, mechanical properties, and hot/wet performance. It is easily processed via vacuum bag/oven, autoclave, or press curing operations. Although TC250 is a 130°C (265°F) cure system, it can be post cured for a higher dry and wet T_g, which enhance the product's elevated temperature performance. TC250 can also be cured or freestanding post cured to 177°C (350°F) to increase its high temperature performance. TC250 is available with virtually all fiber reinforcements in uni-directional tape, slit unidirectional tape, woven, and non-woven prepreg forms.

FEATURES

- **Excellent mechanical properties**
- **Can be initially cured at 82°C (180°F) and post cured freestanding to 130°C (265°F) or 177°C (350°F)**
- **Good toughness**
- **Good surfacing properties**
- **Low laminate void content under low-pressure vacuum curing**
- **NCAMP qualified on a woven fabric**
- **Self-adhesive to core**

PRODUCT TYPE

130°C (265°F) Cure, Toughened Epoxy Resin System

TYPICAL APPLICATIONS

- Aircraft structures
- Space structures
- Radomes and antennae
- Reflectors

SHELF LIFE

Out Life:	Up to 30 days at ambient
Frozen Storage Life:	12 months at -18°C (< 0°F)

Out life is the maximum time allowed at ambient temperature before cure. *Ambient is 18–22°C (65–72°F)

**Out life tested by SBS on 8-ply 15 x 15 cm (6 x 6") fabric laminate, cured in an out-of-autoclave/vacuum bag only (OOA/VBO) environment with 914–948 mbar (27–28 in Hg). Users may need to separately evaluate out life limits on thicker, larger, and more complex parts.*

TYPICAL NEAT RESIN PROPERTIES

Density	1.21 g/cc
Dry T_g	140°C (285°F) cured at 130°C (265°F)
Wet T_g	125°C (257°F) cured at 130°C (265°F)
Dry T_g	180°C (356°F) post cured at 177°C (350°F)
Gel Time	6–10 minutes at 130°C (265°F)

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ELECTRICAL PROPERTIES OF COMPOSITE LAMINATES

TC250 (4581 Quartz)	C/X Band 8–18 GHz	Ku/K Band 18–26.5 GHz	Ka Band 26.5–40 GHz	Q & U Band 40–60 GHz
Dielectric Constant	3.47	3.43	3.42	3.40
Loss Tangent	0.015	0.015	0.011	0.012

TC250 (7781 Fg)	C/X Band 8–18 GHz	Ku/K Band 18–26.5 GHz	Ka Band 26.5–40 GHz	Q & U Band 40–60 GHz
Dielectric Constant	4.73	4.63	4.64	4.59
Loss Tangent	0.026	0.023	0.016	0.019

MECHANICAL PROPERTIES

Property	Condition	Methods	UD Tape (a)		2x2 Twill Carbon Fabric (b)	
Tensile Strength 0°	RTD	ASTM D 3039	2103 MPa	305 ksi	888 Msi	129 ksi
Tensile Modulus 0°	RTD	ASTM D 3039	140 GPa	20.3 Msi	69.6 GPa	10.1 Msi
Tensile Strength 0°	ETW	ASTM D 3039	2089 MPa	303 ksi	916 MPa	133 ksi
Tensile Modulus 0°	ETW	ASTM D 3039	134.4 GPa	19.5 Msi	69.8 GPa	10.1 Msi
Tensile Strength 0°	CTD	ASTM D 3039	2018 MPa	293 ksi	857 MPa	124 ksi
Tensile Modulus 0°	CTD	ASTM D 3039	138 GPa	20 Msi	72.5 GPa	10.5 Msi
Poisson's Ratio	RTD	-	0.30		0.045	
Poisson's Ratio	ETW	-	0.29		0.047	
Poisson's Ratio	CTD	-	0.35		0.071	
Tensile Strength 90°	RTD	ASTM D 3039	56.5 MPa	8.2 ksi	803 MPa	117 ksi
Tensile Modulus 90°	RTD	ASTM D 3039	9.8 GPa	1.42 Msi	68.0 GPa	9.9 Msi
Tensile Strength 90°	ETW	ASTM D 3039	33.8 MPa	4.9 ksi	855 MPa	124 ksi
Tensile Modulus 90°	ETW	ASTM D 3039	8.1 GPa	1.18 Msi	67.3 GPa	9.8 Msi
Tensile Strength 90°	CTD	ASTM D 3039	63 MPa	9.2 ksi	781 MPa	113 ksi
Tensile Modulus 90°	CTD	ASTM D 3039	11.7 GPa	1.69 Msi	73 GPa	10.5 Msi
Compressive Strength 0°	RTD	ASTM D 6641	1731 MPa	251 ksi	898 MPa	130.3 ksi
Compressive Modulus 0°	RTD	ASTM D 6641	133 GPa	19.3 Msi	60.5 GPa	8.8 Msi
Compressive Strength 0°	ETW	ASTM D 6641	1303 MPa	189 ksi	708 MPa	103 ksi
Compressive Modulus 0°	ETW	ASTM D 6641	123.8 GPa	180 Msi	61.8 GPa	9.0 Msi
Compressive Strength 0°	CTD	ASTM D 6641	2011 MPa	292 ksi	956 MPa	139 ksi
Compressive Modulus 0°	CTD	ASTM D 6641	133.7 GPa	19.4 Msi	61.1 GPa	8.9 Msi
Compressive Strength 90°	RTD	ASTM D 6641	-	-	818 MPa	119 ksi
Compressive Modulus 90°	RTD	ASTM D 6641	-	-	65 GPa	9.5 Msi
Compressive Strength 90°	ETW	ASTM D 6641	-	-	714 MPa	104 ksi
Compressive Modulus 90°	ETW	ASTM D 6641	-	-	65.2 GPa	9.5 Msi
Compressive Strength 90°	CTD	ASTM D 6641	-	-	907 MPa	131.5 ksi
Compressive Modulus 90°	CTD	ASTM D 6641	-	-	66.9 GPa	9.7 Msi

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MECHANICAL PROPERTIES

Continued from page 2

Property	Condition	Methods	UD Tape (a)		2x2 Twill Carbon Fabric (b)	
Interlaminar Shear Strength	RTD	ASTM D 2344	82.6 MPa	12 ksi	59.2 MPa	8.6 ksi
Interlaminar Shear Strength	ETW	ASTM D 2344	59.4 MPa	8.6 ksi	46.4 MPa	6.7 ksi
Interlaminar Shear Strength	CTD	ASTM D 2344	89.4 MPa	13 ksi	56.8 MPa	8.2 ksi
Open-Hole Tensile Strength	RTD	ASTM D 5766	405 MPa	59 ksi	377 MPa	55 ksi
Open-Hole Tensile Strength	ETW	ASTM D 5766	438 MPa	63.5 ksi	400 MPa	58 ksi
Open-Hole Tensile Strength	CTD	ASTM D 5766	387 MPa	56.1 ksi	358 MPa	52 ksi
Open-Hole Comp. Strength	RTD	ASTM D 6484	278 MPa	40.3 ksi	338 Msi	49 ksi
Open-Hole Comp. Strength	ETW	ASTM D 6484	259 MPa	37.6 ksi	292 Msi	42 ksi
Filled-Hole Tensile Strength	RTD	ASTM D 6742	471 MPa	68.3 ksi	388 MPa	56 ksi
Filled-Hole Tensile Strength	ETW	ASTM D 6742	476 MPa	69 ksi	404 MPa	59 ksi
Filled-Hole Tensile Strength	CTD	ASTM D 6742	437 MPa	63.4 ksi	380 MPa	55 ksi
Filled-Hole Comp. Strength	RTD	ASTM D 6742	-	-	504 MPa	73 ksi
Filled-Hole Comp. Strength	ETW	ASTM D 6742	-	-	309 MPa	45 ksi
In-Plane Shear Str. (±45)	RTD	ASTM D 3518	102 Msi	14.9 ksi	108 MPa	15.6 ksi
In-Plane Shear Mod. (±45)	RTD	ASTM D 3518	9.9 GPa	1.44 Msi	4.7 GPa	0.68 Msi
In-Plane Shear Str. (±45)	ETW	ASTM D 3518	92.5 MPa	13.4 ksi	86.9 MPa	12.6 ksi
In-Plane Shear Mod. (±45)	ETW	ASTM D 3518	6.3 GPa	0.92 Msi	3.9 GPa	0.57 Msi
In-Plane Shear Str. (±45)	CTD	ASTM D 3518	-	-	124 MPa	18 ksi
In-Plane Shear Mod. (±45)	CTD	ASTM D 3518	-	-	5.5 GPa	0.8 Msi
Single Shear Bearing Str.	RTD	ASTM D 5961	1060 MPa	154 ksi	1,189 MPa	172 ksi
Single Shear Bearing St r.	ETW	ASTM D 5961	733 MPa	106 ksi	901 MPa	131 ksi

STANDARD MODULUS UD TAPE LAMINATE PROPERTIES

(a) Laminate data used UD Tape Prepreg Laminate - HTS-40 12K Carbon Fiber, 150gsm FAW
Vacuum bag oven cure at 14.5 psi, normalized to 60% fiber volume, ETW: 82°C (180°F) Wet, CTD: -55°C (-65°F)
*Wet conditioning done at 63°C (145°F) and 85% RH until complete saturation

CARBON FABRIC LAMINATE PROPERTIES

(b) Laminate data used Fabric Prepreg Laminate - HTS 12K PW Spread Fabric, 193gsm FAW. This data represents limited lot data.
Vacuum bag oven cure at 14.5 psi, normalized to 60% fiber volume, ETW: 82°C (180°F) Wet, CTD: -55°C (-65°F)
*Wet conditioning done at 63°C (145°F) and 85% RH until complete saturation

PRODUCT DATA SHEET

MECHANICAL PROPERTIES

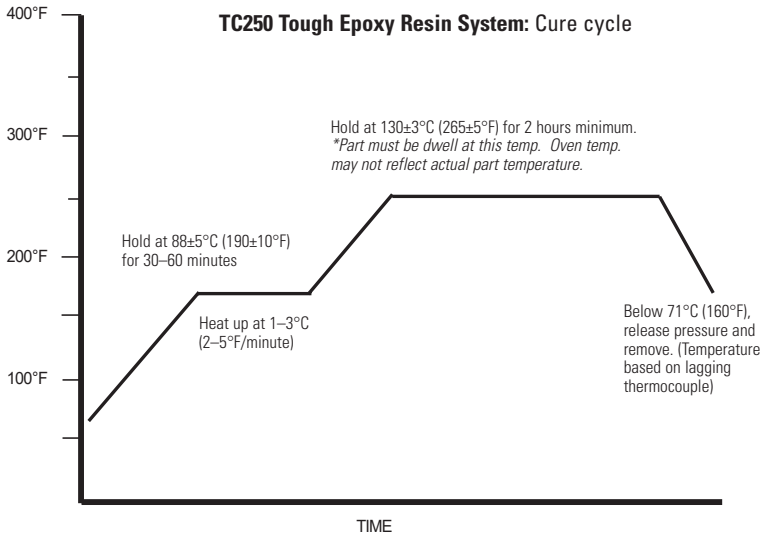
Property	Condition	Methods	Results	
Tensile Strength 0°	RTD	ASTM D 3039	545 MPa	79 ksi
Tensile Modulus 0°	RTD	ASTM D 3039	26.2 GPa	3.8 Msi
Compressive Strength 0°	RTD	ASTM D 6641	536 MPa	77.8 ksi
Compressive Modulus 0°	RTD	ASTM D 6641	26.5 GPa	3.8 Msi
Flexural Strength 90°	RTD	ASTM D 7264	626 MPa	90.8 ksi
Flexural Modulus 90°	RTD	ASTM D 7264	25.4 GPa	3.7 Msi
Short Beam Shear Strength	RTD	ASTM D 2344	60 MPa	8.7 ksi

GLASS FABRIC LAMINATE PROPERIES
Laminate data used 7781 Fg/TC250 OSI, 39% RC, 294gsm FAW. This data represents limited lot data. Normalized to 50% fiber volume

MECHANICAL PROPERTIES

Property	Condition	Methods	4503 AQIII (a)		4581 AQIII (b)	
Tensile Strength 0°	RTD	ASTM D 3039	520 MPa	75.4 ksi	587 MPa	85.2 ksi
Tensile Modulus 0°	RTD	ASTM D 3039	28.1 GPa	4.1 Msi	32.4 GPa	4.7 Msi
Tensile Strength 0°	ETW	ASTM D 3039	183 MPa	26.5 ksi	212 MPa	30.8 ksi
Tensile Modulus 0°	ETW	ASTM D 3039	26.1 GPa	3.8 Msi	25.6 GPa	3.7 Msi
Compressive Strength 0°	RTD	ASTM D 6641	490 MPa	71 ksi	519 MPa	75.3 ksi
Compressive Modulus 0°	RTD	ASTM D 6641	32 GPa	4.6 Msi	27.9 GPa	4.0 Msi
Compressive Strength 0°	ETW	ASTM D 6641	323 MPa	47 ksi	327.5 MPa	47.5 ksi
Compressive Modulus 0°	ETW	ASTM D 6641	22.8 GPa	3.3 Msi	23 GPa	3.3 Msi
Flexural Strength 0°	RTD	ASTM D 7264	660 Msi	95.7 ksi	632 MPa	91.6 ksi
Flexural Modulus 0°	RTD	ASTM D 7264	27 GPa	3.9 Msi	20.5 GPa	3.0 Msi
Flexural Strength 0°	ETW	ASTM D 7264	248 MPa	35.9 ksi	299 MPa	43.4 ksi
Flexural Modulus 0°	ETW	ASTM D 7264	16.2 GPa	2.4 Msi	20.5 GPa	3.0 Msi
In-Plane Shear Str. 0°	RTD	ASTM D 3518	113.5 MPa	16.5 ksi	91.7 MPa	13.3 ksi
In-Plane Shear Mod. 0°	RTD	ASTM D 3518	4.6 GPa	0.67 Msi	4.1 GPa	0.59 Msi
In-Plane Shear Str. 0°	ETW	ASTM D 3518	37.2 MPa	5.39 ksi	37 MPa	5.36 ksi
In-Plane Shear Mod. 0°	ETW	ASTM D 3518	2.2 GPa	0.32 Msi	2.2 GPa	0.32 Msi
Short Beam Shear Strength	RTD	ASTM D 2344	71 MPa	10.3 ksi	56.5 MPa	8.2 ksi
Short Beam Shear Strength	ETW	ASTM D 2344	-	-	26.4 MPa	3.8 ksi

QUARTZ FABRIC LAMINATE PROPERTIES
(a) Laminate data used 4503 AQIII/TC250, 43% RC, 108.5gsm FAW. This data represents limited lot data
Dielectric Constant at 10GHz -3.28 Loss Tangent at 10 Ghz -0.0081
(b) Laminate data used 4581 AQIII/TC250, 36% RC, 284.5gsm FAW. This data represents limited lot data



- Apply 847 mbar (25 inches) Hg vacuum minimum.
- Apply 30–100 psi pressure to autoclave (optional).

EPOXY PREPREG, ADHESIVE, AND RESIN GUIDELINES AND HANDLING PROCEDURES

The following guidelines are provided to our customer to assure that all customers are aware of the procedures to attain the best possible results from Toray Advanced Composites epoxy products. These resin systems will provide sound composite hardware and structures if some simple procedures are followed. Keep in mind that these procedures are good practice for all composite prepreg and adhesive materials and should be used whenever possible.

FREEZER STORAGE

Epoxy resin materials have good shelf life at room temperature; however, the life and performance of the material is best preserved with the following basic guidelines. Refer to the shelf life included in the product certificates. The epoxy material should be sealed in an airtight bag and kept frozen below -18°C (0°F) when not being used for longest life and most consistent performance. A good safety measure is to have a bag of desiccant (silica moisture absorber) in the core of the prepreg roll just in case a pinhole in the bag or other problem occurs.

MOISTURE ABSORPTION AND SENSITIVITY

While very resistant to moisture absorption after cure, epoxies can be adversely affected by moisture uptake prior to cure. For this reason, all materials must be “thoroughly thawed” to room temperature prior to opening the sealed bag to avoid condensation on the material. Also, it is good practice to keep prepreg and in-process hardware in a sealed bag or vacuum bag if to be exposed to the atmosphere for long periods of time.

HANDLING OF MATERIALS

When handling any prepreg materials, one should always be wearing clean, powder-free latex gloves. This will assure that no hand oils are transferred to the prepreg and/or composite during processing. The presence of oils in the part could lead to problems in both mechanical and electrical performance of the part. This also guards against any dermatitis that could occur with certain users.

NONMETALLIC HONEYCOMB AND FOAM CORE USE

When using nonmetallic honeycomb and foam core materials for sandwich structures, the materials should always be dried in an oven prior to lay-up to drive off any moisture that may be in the core. The material should then be cooled in the presence of a desiccant, to avoid any moisture uptake. Following this procedure, it is always a good idea to use the material as soon as possible to avoid rehydration.

Recommended Core Dry Time/Temp: 121°C (250°F) for 3–4 Hours

SELF-ADHESIVE PROPERTIES AND FILM ADHESIVE USE

Toray Advanced Composites epoxy resins have been formulated to have good self-adhesive properties to core materials. However, this should not be taken as a green light to eliminate a film adhesive from a cored, structural piece of hardware. This option has been given by Toray Advanced Composites for customers who are looking for the best electrical properties available by not using a film adhesive. Toray Advanced Composites recommends that the structural integrity be verified to your specification prior to end item usage and takes no responsibility otherwise. If this option is exercised, the following modified cure cycle has been found to work well.

1. **Ramp the part to 66°C–71°C (150°F– 60°F) (keep pressure < 15 psi)**
2. **Dwell for approximately 1 hour**
3. **Ramp the part to the dictated cure temperature for the resin and cure per the provided standard cure cycle**

PROCESSING METHODOLOGY

Epoxy resins can be processed using an autoclave, press, pressclave, or oven cure/vacuum bag. For any application where the optimum properties are needed, Toray Advanced Composites recommends the use of an autoclave.

LAY-UP AREA ENVIRONMENTAL CONTROLS

Toray Advanced Composites recommends that any composite or adhesive lay-up be performed in a clean area visibly free from dust. Any work surfaces should likewise be free of residue, dust, or debris. No eating or smoking shall be allowed in the shop area. For radome materials, conductive materials shall not be allowed in the process area. The processing shop area should be maintained between 16–32°C (60–90°F) with a relative humidity of no greater than 70% RH.

BAGGING FOR CURE

Toray Advanced Composites recommends that cyanate ester composite parts bagged for cure should be performed as follows:

1. **Release the tool surface**
2. **Lay-up part using standard debulking procedures**
3. **Dam the edges of the part for cure**
4. **Place one ply of porous Teflon® or perforated Teflon® onto the bag surface of the part**
5. **Place bleeder layers over the porous Teflon® material and trim to the part periphery**
6. **Place a non-porous layer of Teflon® over the part**
7. **Utilize a breather cloth to facilitate vacuum draw**
8. **Install vacuum bag on the tool for cure**
9. **Follow the provided Toray Advanced Composites cure cycle for the particular resin system**

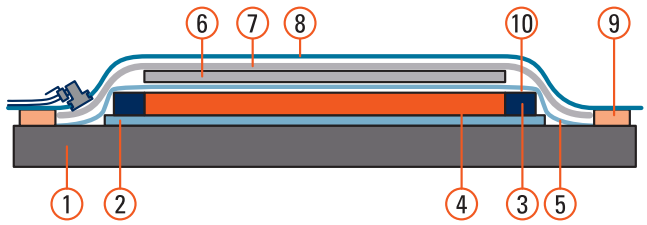
TYPICAL COMPOSITE LAMINATE STACKING SEQUENCE

List of Materials

1. Tool—aluminum, steel, Invar, composite (tool plates must be release coated or film covered). See the list below
2. Release coat or film—Frekote 700NC or 770NC, FEP, TEDLAR
   Lay-up part using standard debulking procedures
3. Silicone edge dams for cure—slightly thicker than laminate
4. Laminate
5. Release coat or film—Frekote 700NC or 770NC, FEP, TEDLAR
6. Caul plate—aluminum, steel, Invar, silicone rubber sheet (metal caul plates must be release coated or wrapped)
7. 2.2 oz/yd^2 polyester breather, 1 or more
8. Vacuum bag
9. Vacuum sealant
10. Glass yarn string (alternatively or additionally breather may wrap over top of dam to contact edge)

Follow the provided Toray Advanced Composites cure cycle for the particular resin system.

Figure 1



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