Toray TC275-1E

Toray Advanced Composites

PRODUCT DATA SHEET

DESCRIPTION

TC275-1E is an extended out time version of the TC275-1 resin system. TC275-1E is a flexible cure toughened epoxy prepreg designed to enable composite part construction with low pressure or vacuum bag only (VBO) cures. The resin system provides a 28-day total out time to facilitate construction of thick or larger composite structures. TC275-1E may be cured at temperatures from 135°C (275°F) to 177°C (350°F) for higher temperature service.

FEATURES

- **Robust OOA/VBO system**
- **Capable of freestanding post cure for higher T_g**
- **Flexible cure prepreg system**
- **Excellent resistance to hot/wet exposure**
- **Long out time and tack life for shop floor handling**
- **High toughness**

PRODUCT TYPE

135–177°C (275–350°F) Cure Toughened Epoxy Resin System

TYPICAL APPLICATIONS

- Aircraft structures
- Launch and space structures
- Thick parts cured under low pressure
- Honeycomb stiffened parts

SHELF LIFE

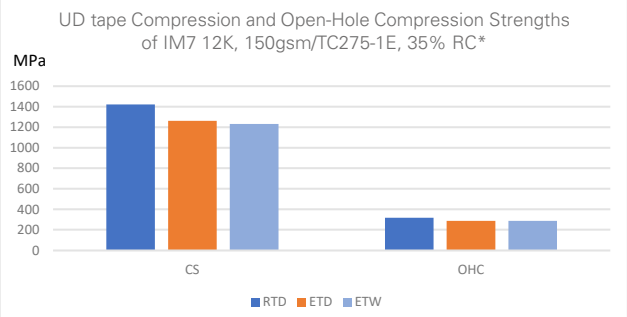
Out Life:	Up to 28 days at ambient
Frozen Storage Life:	12 months at -18°C (< 0°F)

Out life is the maximum time allowed at 21°C (70°F) or below and 60% or less RH before cure, after a single frozen storage cycle in the original unopened packaging at -18°C (0°F) or below for a period not exceeding the frozen storage life noted above.

* Out life tested by SBS on 16-ply 15 x 15 cm (6 x 6 in.) laminate, cured in a out-of-autoclave/vacuum bag only (OOA/VBO) environment with 914–948 mbar (27–28 inHg). Users may need to evaluate out life limits for their own applications due to differing thickness, configuration, and complexity.

TYPICAL NEAT RESIN PROPERTIES

Density	1.17 g/cc
Gel Time at 177°C (350°F)	9–25 min
T_g by DMA after 6 hours at 135°C (275°F)	168°C (334°F)



Toray TC275-1E has outstanding strength retention after hot/wet conditioning.

*ETD and ETW specimens were tested at 82°C (180°F). ETW specimens were soaked for 14 days in 71°C (160°F) water

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MECHANICAL PROPERTIES OF TC275-1E UNI-DIRECTIONAL AND FABRIC PREPREGS

Property	Condition	Method	UD Tape (a)		2x2 Twill Carbon Fabric (b)	
Tensile Strength 0°	RTD	ASTM D 3039	2719 MPa	394 ksi	1058 MPa	154 ksi
Tensile Modulus 0°	RTD	ASTM D 3039	168 GPa	24.3 Msi	67 GPa	9.8 Msi
Tensile Strength 0°	ETD	ASTM D 3039	2564 MPa	372 ksi	1020 MPa	148 ksi
Tensile Modulus 0°	ETD	ASTM D 3039	168 GPa	24.4 Msi	72 GPa	10.5 Msi
Tensile Strength 0°	ETW	ASTM D 3039	2501 MPa	363 ksi	1040 MPa	151 ksi
Tensile Modulus 0°	ETW	ASTM D 3039	171 GPa	24.9 Msi	72 GPa	10.5 Msi
Tensile Strength 90°	RTD	ASTM D 3039	38.1 MPa	5.5 ksi	925 MPa	134 ksi
Tensile Modulus 90°	RTD	ASTM D 3039	8.1 GPa	1.2 Msi	65 GPa	9.4 Msi
Tensile Strength 90°	ETD	ASTM D 3039	37 MPa	5.3 ksi	955 MPa	139 ksi
Tensile Modulus 90°	ETD	ASTM D 3039	7.7 GPa	1.1 Msi	68 GPa	9.8 Msi
Tensile Strength 90°	ETW	ASTM D 3039	32 MPa	4.6 ksi	935 MPa	136 ksi
Tensile Modulus 90°	ETW	ASTM D 3039	7.2 GPa	1.0 Msi	65 GPa	9.5 Msi
Compressive Strength 0°	RTD	ASTM D 695	1418 MPa	206 ksi	795 MPa	115 ksi
Compressive Modulus 0°	RTD	ASTM D 695	164 GPa	23.8 Msi	65 GPa	9.4 Msi
Compressive Strength 0°	ETD	ASTM D 695	1257 MPa	182 ksi	739 MPa	107 ksi
Compressive Modulus 0°	ETD	ASTM D 695	158 GPa	23.0 Msi	63 GPa	9.1 Msi
Compressive Strength 0°	ETW	ASTM D 695	1229 MPa	178 ksi	694 MPa	101 ksi
Compressive Modulus 0°	ETW	ASTM D 695	148 GPa	21.4 Msi	62 GPa	9.0 Msi
Compressive Strength 90°	RTD	ASTM D 695	240 MPa	34.8 ksi	873 MPa	127 ksi
Compressive Modulus 90°	RTD	ASTM D 695	9.9 GPa	1.4 Msi	64 GPa	9.3 Msi
Compressive Strength 90°	ETD	ASTM D 695	192.9 MPa	28.0 ksi	784 MPa	114 ksi
Compressive Modulus 90°	ETD	ASTM D 695	9.3 GPa	1.4 Msi	63 GPa	9.1 Msi
Compressive Strength 90°	ETW	ASTM D 695	189.2 MPa	27.4 ksi	737 MPa	107 ksi
Compressive Modulus 90°	ETW	ASTM D 695	9.1 GPa	1.3 Msi	62 GPa	9.0 Msi
Compressive Strength	RTD	ASTM D 6641	1499 MPa	217 ksi	715 MPa	104 ksi
Compressive Modulus 0°	RTD	ASTM D 6641	-	-	56 GPa	8.1 Msi
Compressive Strength	ETD	ASTM D6641	1348 MPa	196 ksi	691 MPa	100 ksi
Compressive Modulus 0°	ETD	ASTM D 6641	-	-	59 MPa	8.6 Msi
Compressive Strength	ETW	ASTM D 6641	1278 MPa	185 ksi	622 MPa	90.2 ksi
Compressive Modulus 0°	ETW	ASTM D 6641	-	-	58 MPa	8.4 Msi
Flexural Strength 0°	RTD	ASTM D 790	2004 MPa	291 ksi	1138 MPa	165 ksi
Flexural Modulus 0°	RTD	ASTM D 790	96 GPa	13.9 Msi	43 MPa	6.3 Msi
Flexural Strength 0°	ETD	ASTM D 790	1586 MPa	230 ksi	975 GPa	141 ksi
Flexural Modulus 0°	ETD	ASTM D 790	94 GPa	13.6 Msi	44 MPa	6.4 Ksi
Flexural Strength 0°	ETW	ASTM D 790	1436 MPa	208 ksi	871 GPa	126 ksi
Flexural Modulus 0°	ETW	ASTM D 790	91 GPa	13.3 Msi	45 MPa	6.5 Msi
ILSS 0°	RTD	ASTM D 2344	104 MPa	15.1 ksi	64 GPa	9.2 ksi
ILSS 0°	ETD	ASTM D 2344	81 MPa	11.7 ksi	61 MPa	8.8 ksi
ILSS 0°	ETW	ASTM D 2344	68 MPa	9.8 ksi	59 MPa	8.5 ksi

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MECHANICAL PROPERTIES OF TC275-1E UNI-DIRECTIONAL AND FABRIC PREPREGS

Property	Condition	Method	UD Tape (a)		2x2 Twill Carbon Fabric (b)	
Filled-Hole Tensile Strength (45/0/-45/90)	RTD	ASTM D 6742	514 MPa	75 ksi	398 MPa	57.7 ksi
Open-Hole Tensile Strength	RTD	ASTM D 5766	503 MPa	73 ksi	386 MPa	55.9 ksi
Open-Hole Tensile Strength	ETD	ASTM D 5766	474 MPa	69 ksi	390 MPa	56.6 ksi
Open-Hole Tensile Strength	ETW	ASTM D 5766	456 MPa	66 ksi	382 MPa	55.5 ksi
Open-Hole Comp. Strength	RTD	ASTM D 6484	318 MPa	46 ksi	326 MPa	47.3 ksi
Open-Hole Comp. Strength	ETD	ASTM D 6484	287 MPa	42 ksi	306 MPa	44 ksi
Open-Hole Comp. Strength	ETW	ASTM D 6484	287 MPa	42 ksi	285 MPa	41 ksi
In-Plane Shear Str. (+/-45)	RTD	ASTM D 3518	121 MPa	17.5 ksi	132 MPa	19 ksi
In-Plane Shear Str. (+/-45)	ETD	ASTM D 3518	116 MPa	16.9 ksi	115 MPa	17 ksi
In-Plane Shear Str. (+/-45)	ETW	ASTM D 3518	102.0 MPa	14.8 ksi	97 MPa	14 ksi
In-Plane Shear Mod. (+/-45)	RTD	ASTM D 3518	3.7 GPa	0.54 Msi	3.5 MPa	0.51 Msi
In-Plane Shear Mod. (+/-45)	ETD	ASTM D 3518	3.4 GPa	0.49 Msi	3.4 GPa	0.49 Msi
In-Plane Shear Mod. (+/-45)	ETW	ASTM D 3518	3.2 GPa	0.47 Msi	2.9 GPa	0.42 Msi
V-Notch Shear Strength	RTD	ASTM D 5379	62.0 MPa	8.99 ksi	62.8 MPa	9.10 ksi
V-Notch Shear Strength	ETD	ASTM D 5379	54.8 MPa	7.95 ksi	-	-
V-Notch Shear Strength	ETW	ASTM D 5379	47.4 MPa	6.88 ksi	-	-
V-Notch Shear Modulus	RTD	ASTM D 5379	3.72 GPa	0.54 Msi	3.65 GPa	0.53 Msi
V-Notch Shear Modulus	ETD	ASTM D 5379	3.31 GPa	0.48 Msi	-	-
V-Notch Shear Modulus	ETW	ASTM D 5379	3.24 GPa	0.47 Msi	-	-
Compressive Strength 90°	RTD	ASTM D 6641	-	-	726 MPa	105 ksi
Compressive Modulus 90°	RTD	ASTM D 6641	-	-	57 GPa	8.3 Msi
Compressive Strength 90°	ETD	ASTM D 6641	-	-	712 MPa	103 ksi
Compressive Modulus 90°	ETD	ASTM D 6641	-	-	57 GPa	8.3 Msi
Compressive Strength 90°	ETW	ASTM D 6641	-	-	622 MPa	90 ksi
Compressive Modulus 90°	ETW	ASTM D 6641	-	-	58 GPa	8.3 Msi
CAI at 6.7 J/mm (1500 in-lb/in)	RTD	ASTM D 7136/7137	-	-	223 MPa	32 ksi
Water Absorption* %			0.51%		0.46%	
Laminate T_g (onset, DMA, Dry)			175°C (347°F)		174°C (345°F)	
Laminate T_g (onset, DMA, Wet)			152°C (306°F)		154°C (309°F)	

(a) UD tape data from IM7 12K, 150gsm/TC275-1E, 35% resin content. All data was normalized to 60% fiber volume by acid digestion method except for ILSS, TS/TM 90°, and CS/CM 90°. CS6641 was back calculated to zero. V-Notch strength and modulus were offset to 0.5%. ETD and ETW specimens were tested at 82°C (180°F). ETW specimens were soaked for 14 days in 71°C (160°F) water. Cure A was used in mechanical data above.

(b) Fabric data from HTS40 3K 2x2 Twill, 193gsm/TC275-1E, 42% resin content. All data was normalized to 55% fiber volume by acid digestion method except for ILSS, V-Notch strength, and modulus, which were offset to 0.5%. ETD and ETW specimens were tested at 82°C (180°F). ETW specimens were soaked for 14 days in 71°C (160°F) water. Cure A was used in mechanical data above.

*14 day soak at 71°C (160°F) in water.

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PRODUCT DATA SHEET

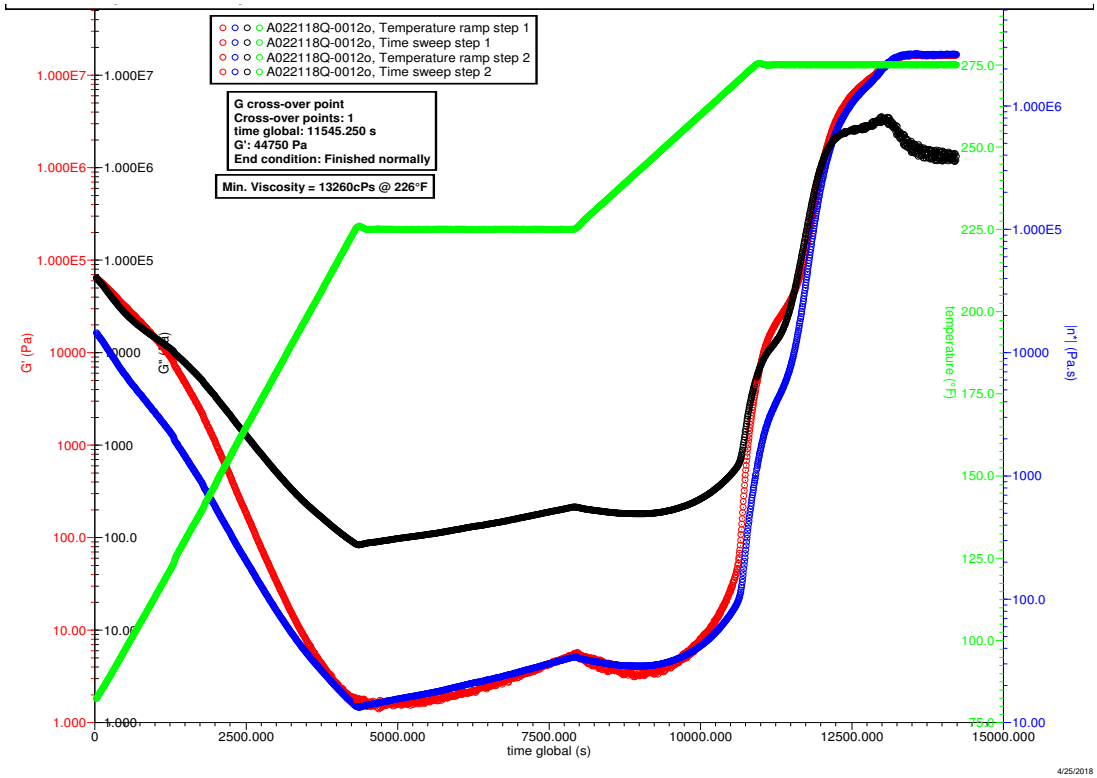
TYPICAL CURE PARAMETERS

Cure A - 1°C (2°F)/minute to 107°C (225°F) and hold for 1 hour, then ramp at 0.6°C (1°F)/minute to 135°C (275°F) and hold for 6 hours, followed by cool down to 49°C (120°F) at 2.8°C (5°F)/minute or less. Vacuum of 914–948 millibar (27–28 inHg) should be applied before start of cure and held throughout cure cycle and cool down.

Cure B - 1°C (2°F)/minute to 107°C (225°F) and hold for 1 hour, then ramp at 0.6°C (1°F)/minute to 135°C (275°F) for 3 hours, followed by freestanding post cure for 2 hours at 177°C (350°F). Vacuum of 914–948 millibar (27–28 inHg) should be applied before start of cure and held throughout cure cycle and cool down.

Cure C - 1°C (2°F)/minute to 107°C (225°F) for 1 hour, then cure at 177°C (350°F) for 2 hours. Vacuum of 914–948 millibar (27–28 inHg) should be applied before start of cure and held throughout cure cycle and cool down.

TC275-1E Dynamic Viscosity @ -1°C (2°F)/min to 107°C (225°F) Hold 1hr, 0.6°C (1°F)/min to 135° C (275°F) Hold Until Gel



EPOXY PREPREG, ADHESIVE, AND RESIN GUIDELINES AND HANDLING PROCEDURES

The following guidelines are provided to our customers to assure that best practices are used to attain the best results from Toray Advanced Composites epoxy products. Keep in mind that these procedures represent best practices for all composite prepreg and adhesive materials.

FREEZER STORAGE

Epoxy resin materials have good out life at room temperature; however, the life and performance of the material is best preserved with the following basic guidelines. Refer to the frozen storage life included in the product certifications. The epoxy material should be sealed in an airtight bag and kept frozen below -18°C (0°F) when not being used to assure the longest life and most consistent performance. It is also best practice to include active desiccant in the core of the prepreg roll to provide protection from moisture ingress.

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 completely 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 it will be exposed to the atmosphere for significant periods of time.

HANDLING OF MATERIALS

When handling any prepreg materials, one should always wear clean, powder-free latex gloves. This will assure that no hand oils are transferred to the prepreg or composite during processing. The presence of oils in the part could lead to problems with mechanical and electrical performance of the part. This also helps protect against dermatitis that may occur with some 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 or volatiles that may be in the core. The core should be cooled and sealed with desiccant to avoid moisture re-uptake. Following drying, the material should be used as soon as possible.

DEBULK LAY-UP MATERIAL SEQUENCE FROM TOOL SURFACE TO BAGGING MATERIALS

1. Bottom tool
2. Non-porous FEP
3. Prepreg
4. Porous TX1040
5. Non-porous FEP
6. Caul plate
7. Breather (woven or thick breather)
8. Vacuum bag

A robust debulking procedure is necessary to minimize entrapped air between plies as shown in Figure 1. Vacuum level should be at least 914 millibars (27 inHg). TC275-1E UD tape was debulked every 4 plies for 5–10 minutes. TC275-1E woven fabric was debulked every 2 plies for 5–10 minutes. An additional ply of porous Teflon coated glass (TX1040) was used to help with the removal of entrapped air, and it was replaced every 2–3 cycles.

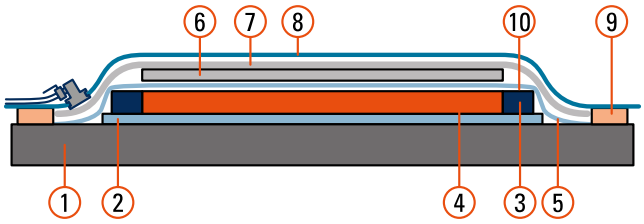
PRODUCT DATA SHEET

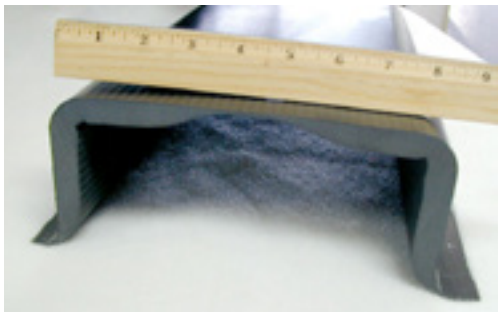
TYPICAL COMPOSITE LAMINATE STACKING SEQUENCE

List of Materials

1. Tool–aluminum, steel, Invar, composite (tool plates must be release coated or film covered).
2. Release coat or film–Frekote 700NC or 770NC, FEP, TEDLAR
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)

Figure 1





Demonstration part of 100+ plies ofTC275-1E, with less than 1% voids.

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