

### DESCRIPTION

TC275-1 is a dual cure toughened epoxy prepreg designed to facilitate composite part construction with low pressure or vacuum pressure cures. The resin system features a 14 day tack life and 14 day total out time to allow the construction of thick or larger composite structure. TC275-1 may be cured at a lower temperature of 135°C (275°F) or can be cured at 177°C (350°F) for higher temperature service.

### FEATURES

- › **Dual cure prepreg system**
- › **High toughness**
- › **Excellent resistance to hot/wet exposure**
- › **Robust processing and low voids under vacuum cure pressure**
- › **Long outtime and tack life for shop floor handling**

### PRODUCT TYPE

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

### TYPICAL APPLICATIONS

- › Aircraft structures
- › Thick parts cured under low pressure
- › Honeycomb stiffened parts

### SHELF LIFE

<b>Tack Life:</b>	Up to 14 days at ambient
<b>Out Life:</b>	Up to 14 days at ambient
<b>Frozen Storage Life:</b>	12 months at -18°C (<0°F)

Tack life is the time during which the prepreg retains enough tack, drape and handling for easy component lay-up.

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") laminate. Users may need to separately evaluate out life limits on thicker, more complex parts.*

### NEAT RESIN PROPERTIES

Resin Density	1.17 g/cc
T <sub>g</sub> by DMA w/Post Cure 177°C (350°F) 2 hours Dry	183°C (362°F)
T <sub>g</sub> by DMA Wet (saturated @ 77°C (160°F) 85% RH)	136°C (277°F)
Resin Gel Time @ 135°C (275°F)	19-23 min.
Gel Time @ 177°C (350°F)	9-14 min.
Dynamic Viscosity	~12k cps @ 135°C (275°F) (-1.6°C (-3°F) /min to 275°F to gel)
T <sub>g</sub> cured 3°F (1.6°C)/min to 135°C (275°F) hold for 6 hours T <sub>g</sub> by DMA Dry	164°C (327°F)



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## MECHANICAL PROPERTIES

Properties	Condition	Method	A - Cured at 135°C (275°F)		B - Cured at 177°C (350°F)	
			Value 1	Value 2	Value 1	Value 2
Tensile Strength 0°	RTD	ASTM D3039	2,672 MPa	388 ksi	2,892 MPa	420 ksi
Tensile Modulus 0°	RTD	ASTM D3039	152.4 GPa	22.1 Msi	146.2 GPa	21.2 Msi
Tensile Strength 0°	ETD	ASTM D3039	2,310 MPa	335 ksi	2,747 MPa	398 ksi
Tensile Modulus 0°	ETD	ASTM D3039	148.2 GPa	21.5 Msi	160.0 GPa	23.2 Msi
Tensile Strength 0°	ETW	ASTM D3039	2,407 MPa	349 ksi	2,650 MPa	384 ksi
Tensile Modulus 0°	ETW	ASTM D3039	153.1 GPa	22.2 Msi	157.9 GPa	22.9 Msi
Compressive Strength 0°	RTD	ASTM D695	1,530 MPa	222 ksi	1,548 MPa	225 ksi
Compressive Modulus 0°	RTD	ASTM D695	126.9 GPa	18.4 Msi	139.3 GPa	20.2 Msi
Compressive Strength 0°	ETD	ASTM D695	1,488 MPa	216 ksi	1,491 MPa	216 ksi
Compressive Modulus 0°	ETD	ASTM D695	123.4 GPa	17.9 Msi	133.1 GPa	19.3 Msi
Compressive Strength 0°	ETW	ASTM D695	1,450 MPa	210 ksi	1,400 MPa	203 ksi
Compressive Modulus 0°	ETW	ASTM D695	123.4 GPa	17.9 Msi	135.1 GPa	19.6 Msi
Compressive Strength 0°	RTD	ASTM D6641	1,533 MPa	222 ksi	1,627 MPa	236 ksi
Compressive Strength 0°	ETD	ASTM D6641	1,449 MPa	210 ksi	1,391 MPa	202 ksi
Compressive Strength 0°	ETW	ASTM D6641	1,420 MPa	206 ksi	1,375 MPa	199 ksi
In Plane Shear Strength	RTD	ASTM D3846	102 MPa	15 ksi	106 MPa	15 ksi
In Plane Shear Modulus	RTD	ASTM D3846	3.4 GPa	0.5 Msi	4.1 GPa	0.6 Msi
Open Hole Tensile Strength	RTD	ASTM D5766	459 MPa	67 ksi	482 MPa	70 ksi
Open Hole Tensile Strength	ETD	ASTM D5766	468 MPa	68 ksi	492 MPa	71 ksi
Open Hole Tensile Strength	ETW	ASTM D5766	465 MPa	67 ksi	503 MPa	73 ksi
Open Hole Comp. Strength	RTD	ASTM D6484	332 MPa	48 ksi	300 MPa	44 ksi
Open Hole Comp. Strength	ETD	ASTM D6484	327 MPa	47 ksi	280 MPa	41 ksi
Open Hole Comp. Strength	ETW	ASTM D6484	315 MPa	46 ksi	270 MPa	39 ksi
Flexural Strength 0°	RTD	ASTM D790	2,195 MPa	318 ksi	2,623 MPa	380 ksi
Flexural Modulus 0°	RTD	ASTM D790	96.5 GPa	14 Msi	115.8 GPa	16.8 Msi
Flexural Strength 0°	ETD	ASTM D790	1,824 MPa	265 ksi	1,910 MPa	277 ksi
Flexural Modulus 0°	ETD	ASTM D790	88.9 GPa	12.9 Msi	103.4 GPa	15.0 Msi
Flexural Strength 0°	ETW	ASTM D790	1,584 MPa	230 ksi	1,625 MPa	236 ksi
Flexural Modulus 0°	ETW	ASTM D790	86.9 GPa	12.6 Msi	88.9 GPa	12.6 Msi
Flexural Strength 0°	ETD	ASTM D790	1,824 MPa	265 ksi	1,910 MPa	277 ksi
Flexural Modulus 0°	ETD	ASTM D790	88.9 GPa	12.9 Msi	103.4 GPa	15.0 Msi
Flexural Strength 0°	ETW	ASTM D790	1,584 MPa	230 ksi	1,625 MPa	236 ksi
Flexural Modulus 0°	ETW	ASTM D790	86.9 GPa	12.6 Msi	88.9 GPa	12.6 Msi
ILSS 0°	RTD	ASTM D2344	107 MPa	16 ksi	109 MPa	16 ksi
ILSS 0°	ETD	ASTM D2344	85 MPa	12 ksi	74 MPa	11 ksi
ILSS 0°	ETW	ASTM D2344	68 MPa	10 ksi	65 MPa	9 ksi
Laminate DMA Onset T <sub>g</sub> Dry			159°C (318°F)		186°C (367°F)	
Laminate DMA Onset T <sub>g</sub> Wet			146°C (295°F)		156°C (313°F)	

(1) Unidirectional laminate data used Grafil TR50S 15K fiber with a FAW 150 gsm, 35% RC. The data below represents limited lot data. Results above were normalized to 60%. Soak condition 71°C (160°F), 85% RH to saturation.

1. Cure A results, ETD and ETW tested at 82°C (180°F)
2. Cure B results ETD and ETW tested at 121°C (250°F)

## MECHANICAL PROPERTIES

Properties	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	100.3 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

### MECHANICAL PROPERTIES

*Continued from page 3*

Properties	Condition	Method	UD Tape (a)		2x2 Twill Carbon Fabric (b)	
Fill Hole Tensile (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 3846	121 MPa	17.5 ksi	132 MPa	19 ksi
In Plane Shear Str. (+/-45)	ETD	ASTM D 3846	116 MPa	16.9 ksi	115 MPa	17 ksi
In Plane Shear Str. (+/-45)	ETW	ASTM D 3846	102.0 MPa	14.8 ksi	97 MPa	14 ksi
In Plane Shear Mod. (+/-45)	RTD	ASTM D 3846	3.7 GPa	0.54 Msi	3.5 MPa	0.51 Msi
In Plane Shear Mod. (+/-45)	ETD	ASTM D 3846	3.4 GPa	0.49 Msi	3.4 GPa	0.49 Msi
In Plane Shear Mod. (+/-45)	ETW	ASTM D 3846	3.2 GPa	0.47 Msi	2.9 GPa	0.42 Msi
V-Notch Shear Strength 0°	RTD	ASTM D 5379	65.7 MPa	9.5 ksi	70 MPa	10.1 ksi
V-Notch Shear Strength 0°	ETD	ASTM D 5379	57.9 MPa	8.4 ksi	-	-
V-Notch Shear Strength 0°	ETW	ASTM D 5379	50.5 MPa	7.3 ksi	-	-
V-Notch Shear Modulus 0°	RTD	ASTM D 5379	4.1 GPa	0.60 Msi	4.1 GPa	0.60 Msi
V-Notch Shear Modulus 0°	ETD	ASTM D 5379	3.7 GPa	0.53 Msi	-	-
V-Notch Shear Modulus 0°	ETW	ASTM D 5379	3.6 GPa	0.52 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 @ 6.7 J/mm (1500 in-lb/in)	RTD	ASTM D 7136/7137	-	-	223 MPa	32 ksi
Water Absorption %			0.51% - after 14 days soaked @ 71°C (160°F) water temperature		0.46% - after 14 days soaked @ 71°C (160°F) water temperature	
Laminate T <sub>g</sub> (onset, DMA, Dry)			175°C (347°F)		174°C (345°F)	
Laminate T <sub>g</sub> (onset, DMA, Wet)			152°C (306°F)		154°C (309°F)	

**(a)** Unitape 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 represents 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 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.

### MECHANICAL PROPERTIES

Properties	Condition	Method	QiSO Fabric (a)		PW Fabric (b)		% Diff
Tensile Strength	RTD	ASTM D 3039	775 MPa	112 ksi	657 MPa	95 ksi	18%
Tensile Modulus	RTD	ASTM D 3039	47 GPa	6.7 Msi	46.2 GPa	6.7 Msi	
Tensile Strength 90°	RTD	ASTM D 3039	681 MPa	99 ksi	648 MPa	94 ksi	
Tensile Modulus 90°	RTD	ASTM D 3039	43 GPa	6.2 Msi	44.6 GPa	6.5 Msi	
Compression Strength 0°	RTD	ASTM D 6641	603 MPa	87 ksi	465 MPa	67 ksi	30%
Compression Modulus 0°	RTD	ASTM D 6641	42 GPa	6.2 Msi	41.8 GPa	6.1 Msi	
Compression Strength 90°	RTD	ASTM D 6641	464 MPa	67 ksi	425 MPa	62 ksi	9%
Compression Modulus 90°	RTD	ASTM D 6641	43 GPa	6.2 Msi	43.1 GPa	6.2 Msi	
In-Plane Shear Strength	RTD	ASTM D 7078	305 MPa	44 ksi	360 MPa	52 ksi	
In-Plane Shear Modulus	RTD	ASTM D 7078	16 GPa	2.4 Msi	17 GPa	2.5 Msi	
Open-Hole Compression Strength	RTD	ASTM D 6484	374 MPa	54 ksi	298 MPa	43 ksi	26%

Data supplied by A&P Technology, actual mechanical data provided by CTL. The above data is part of a SAMPE paper presented on 2015 titled "A Comparative Evaluation of Quasi-Isotropic Laminates Composed of Either Braided Tri-axial Fabric or Woven Fabric".

**(a)** Represents data from TC275-1 QISO fabric at 272gsm, 38% resin content. All data normalized to 55% fiber volume.

**(b)** Represents data from TC275-1 plain weave fabric at 205gsm, 38% resin content in 0°/45° orientation. All data normalized to 55% fiber volume.

### TYPICAL CURE PARAMETERS

**Cure A** - 1°C (2°F)/minute to 107°C (225°F) and hold for 1 hour, then 0.6°C (1°F)/minute to 135°C (275°F) for 6 hours, follow by cool down to 49°C (120°F) at 2.8°C (5°F)/minute or less.

**Cure B** - 1°C (2°F)/minute to 107°C (225°F) and hold for 1 hour, then 0.6°C (1°F)/minute to 135°C (275°F) for 3 hours, follow by freestanding post cure for two hours at 177°C (350°F).

**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.

## 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 TenCate Advanced Composites (TCAC) 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 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 certifications. 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 to assure the best protection from moisture imgression.

### 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 long 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 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 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 that may be in the core. The core should be cooled in the presence of a desiccant to avoid moisture uptake. Following drying, it is always best to use the material as soon as possible. Recommended core dry time/temp: 121°C (250°F) for 3–4 hours.

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

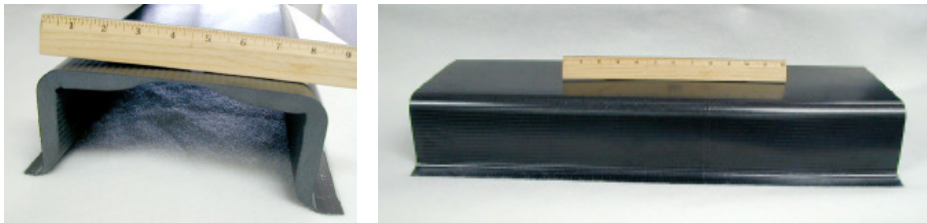
- 1. Bottom Tool**
- 2. Non-porous FEP**
- 3. Prepreg**
- 4. Porous TX1040**
- 5. Non-porous FEP**
- 6. Caul plate**
- 7. Breather (woven or thick breather)**
- 8. Vacuum bag**

A robust debulking procedure is necessary to minimize entrapped air between plies as shown in Figure 1. Vacuum level should be at least at 27 in. Hg. TC275-1 was debulked every 4 plies for 5–10 minutes. TC275-1 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.

### COMPOSITE LAMINATE STACKING SEQUENCE

#### List of Materials

1. Tool – aluminum, steel, Invar, composite (tool plates must be release coated or film covered). See below.
2. Release coat or film – Frekote 700NC or 770NC, FEP, TEDLAR
3. Silicone edge dams – 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<sup>2</sup> 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)



Demonstration part of 100+ ply of TC275-1, less than 1% voids.

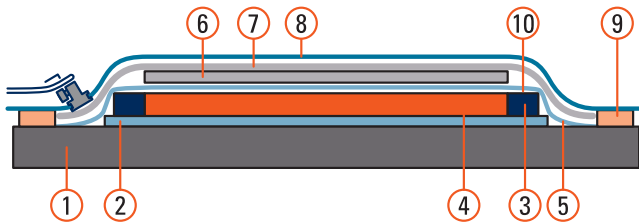


Figure 1

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