

# PRODUCT DATA SHEET



TENCATE ADVANCED COMPOSITES

## TC350-1 Out-of-Autoclave Resin System

### PRODUCT TYPE

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

### TYPICAL APPLICATIONS

- Aircraft Structures
- Space Structures
- Radomes and Antennas
- Reflectors

### CURE CYCLE

#### Cure Profile A:

1-2°F (0.6-1.1°C)/min to 225°F(107°C) and hold for 60 minutes, then 1-2°F(0.6-1.1°C)/min. to 350°F/177°C for 2-2.5 hours, cool down at 5-10° F (2.8-5.6°C)/min. to <120°F/49°C before taking the parts out of the oven. Minimum vacuum required/recommended >27" Hg

#### Alternate low temperature initial cure profile:

1-2°F (0.6-1.1°C)/min. to 225°F/107°C and hold for 60 min., then 1-2°F (0.6-1.1°C) /min. to 275°F/135°C and hold for at least 3 hours, cool 5-10°F/min. to <120°F/49°C before taking the parts out of the oven. Minimum vacuum required/recommended >27" Hg. Additional post cure at 350°F for at least 2 hours is required.

#### Free standing post cure:

3-4°F (1.7-2.2°C)/min. to 275°F/135°C and then 1-2°F (0.6-1.1°C)/min. to 350°F/177°C and hold for at least 2 hours.

### SHELF LIFE

#### Tack Life

21 days tack life at 77°F (25°C)

#### Out Life

45 days out life 77°F (25°C)

#### Frozen Storage Life

12 months storage life at <0°F (-18°C)

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 room temperature before cure.

### PRODUCT DESCRIPTION

TC350-1 is a toughened matrix for structural advanced composite applications. TC350-1 offers an excellent balance of toughness, mechanical property translation and hot/wet performance and is easily processed via out of autoclave or press curing operations. TC350-1 develops a 376°F (191°C) Tg after a 350°F (177°C) cure, which coupled with low moisture absorption translates into excellent hot/wet performance. TC350-1 is available with virtually all fiber reinforcements in unidirectional tape, slit unidirectional tape, woven and non-woven prepreg formats.

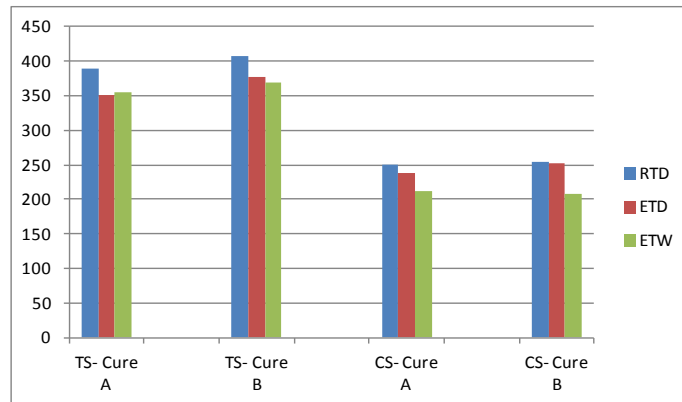
### PRODUCT BENEFITS/FEATURES

- Robust under vacuum only processing (very low void content)
- Excellent mechanical property translation
- High toughness
- Easy processing
- Excellent tack properties
- Good surfacing properties

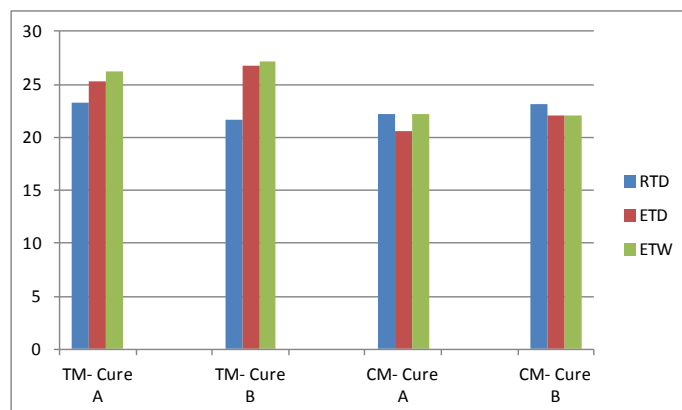
### TYPICAL NEAT RESIN PROPERTIES

Density .....	1.3 g/cc
Dry Tg (by DMA) .....	376°F (191°C) cured at 350°F (177°C)
Wet Tg (by DMA) .....	320°F (160°C) cured at 350°F (177°C) after saturation at 85% RH and 160°F (71°C)
Gel Time .....	10 - 12 minutes at 350°F (177°C)

### LAMINATE MECHANICAL PROPERTY COMPARISON - STRENGTH IM-7 12K. FAW 150 GSM, 36% RC



### LAMINATE MECHANICAL PROPERTY COMPARISON - MODULUS IM-7 12K. FAW 150 GSM, 36% RC



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## TC350-1 Out-of-Autoclave Resin System

**LAMINATE DATA USED IM-7 12K. FAW 150 GSM, 36% RC** *The data below represents limited lot data.*

Properties	Condition	Method	Results (A)		Results (B)	
Tensile Strength 0°	RTD	ASTM D3039	390 ksi	2689.0 MPa	407 ksi	2806 MPa
Tensile Modulus 0°	RTD	ASTM D3039	23.3 Msi	160.6 GPa	21.7 Msi	149.6 GPa
Tensile Strength 0°	ETD	ASTM D3039	351 ksi	2416.6 MPa	377 ksi	2600 MPa
Tensile Modulus 0°	ETD	ASTM D3039	25.3 Msi	174.4 GPa	26.8 Msi	184.8 GPa
Tensile Strength 0°	ETW	ASTM D3039	355 ksi	2447.6 MPa	359 ksi	2475 MPa
Tensile Modulus 0°	ETW	ASTM D3039	26.2 Msi	180.6 GPa	27.1 Msi	186.8 GPa
Tensile Strength 90°	RTD	ASTM D3039	10.0 ksi	68.9 MPa	13.7 ksi	94.5 MPa
Tensile Modulus 90°	RTD	ASTM D3039	1.5 Msi	10.3 GPa	1.3 Msi	9.0 GPa
Tensile Strength 90°	ETD	ASTM D3039	7.2 ksi	49.6 MPa	9.1 ksi	62.7 MPa
Tensile Modulus 90°	ETD	ASTM D3039	1.5 Msi	10.3 GPa	1.3 Msi	8.9 GPa
Tensile Strength 90°	ETW	ASTM D3039	6.1 ksi	42.0 MPa	3.7 ksi	25.5GPa
Tensile Modulus 90°	ETW	ASTM D3039	1.5 Msi	10.3 GPa	1.0 Msi	6.9 GPa
Compressive Strength 0°	RTD	ASTM D695	251 ksi	1730.6 MPa	255 ksi	1758 MPa
Compressive Modulus 0°	RTD	ASTM D695	22.2 Msi	153.1 GPa	23.1 Msi	159.3 GPa
Compressive Strength 0°	ETD	ASTM D695	238 ksi	1642.3 MPa	253 ksi	1744 MPa
Compressive Modulus 0°	ETD	ASTM D695	20.6 Msi	142.0 GPa	22 Msi	151.7 GPa
Compressive Strength 0°	ETW	ASTM D695	213 ksi	1468.6 MPa	208 ksi	1434 MPa
Compressive Modulus 0°	ETW	ASTM D695	22.2 Msi	152.9 GPa	22.1 Msi	152.4 GPa
Compressive Strength 90°	RTD	ASTM D695	48.9 ksi	337.2 MPa	49.6 ksi	342 MPa
Compressive Modulus 90°	RTD	ASTM D695	1.5 Msi	10.3 GPa	1.5 Msi	10.3 GPa
Compressive Strength 90°	ETD	ASTM D695	36.6 ksi	252.3 MPa	34.3 ksi	236 MPa
Compressive Modulus 90°	ETD	ASTM D695	1.4 Msi	9.7 GPa	1.3 Msi	9.0 GPa
Compressive Strength 90°	ETW	ASTM D695	27.8 ksi	191.6 MPa	26.7 ksi	184 MPa
Compressive Modulus 90°	ETW	ASTM D695	1.3 Msi	9.0 GPa	1.2 Msi	8.3 GPa
Compression Strength	RTD	ASTM D6641	253 ksi	1744.2 MPa	227 ksi	1565 MPa
Compression Strength	ETD	ASTM D6641	225 ksi	1550.0 MPa	210 ksi	1448 MPa
Compression Strength	ETW	ASTM D6641	189.1 ksi	1303.1 MPa	185.1 ksi	1276.2 MPa
Open Hole Tensile Strength	RTD	ASTM D5766	68.4 ksi	471.6 MPa	N/A	N/A
Open Hole Tensile Strength	ETD	ASTM D5766	71.9 ksi	495.7 MPa	N/A	N/A
Open Hole Tensile Strength	ETW	ASTM D5766	68.0 ksi	468.8 MPa	N/A	N/A
Open Hole Comp. Strength	RTD	ASTM D6484	44.6 ksi	307.5 MPa	N/A	N/A
Open Hole Comp. Strength	ETD	ASTM D6484	42.3 ksi	291.6 MPa	N/A	N/A
Open Hole Comp. Strength	ETW	ASTM D6484	35.6 ksi	245.4 MPa	N/A	N/A
Flexural Strength	RTD	ASTM 7264	330 ksi	2275.3 MPa	343 ksi	2364 MPa
Flexural Modulus	RTD	ASTM 7264	17.9 Msi	123.4 GPa	16.9 Msi	117 GPa
Flexural Strength	ETD	ASTM 7264	266.5 ksi	1837.4 MPa	264 ksi	1820 MPa

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## TC350-1 Out-of-Autoclave Resin System

### LAMINATE DATA USED IM-7 12K. FAW 150 GSM, 36% RC

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Properties	Condition	Method	Results (A)		Results (B)	
Flexural Modulus	ETD	ASTM 7264	15.3 Msi	105.5 GPa	16.8 Msi	115.8 GPa
Flexural Strength	ETW	ASTM 7264	188.4 ksi	1298.9 MPa	222.0 ksi	1530.6 MPa
Flexural Modulus	ETW	ASTM 7264	13.5 Msi	93.1 GPa	13.8 Msi	95.1 GPa
In Plane Shear Strength (+/-45)	RTD	ASTM D3518	19.0 ksi	136.5 MPa	17.1 ksi	117.9 MPa
In Plane Shear Modulus (+/-45)	RTD	ASTM D3518	0.7 Msi	4.8 GPa	0.7 Msi	4.8 GPa
In Plane Shear Strength (+/-45)	ETD	ASTM D3518	16.8 ksi	115.8 MPa	17.0 ksi	117.2 MPa
In Plane Shear Modulus (+/-45)	ETD	ASTM D3518	0.6 Msi	3.8 GPa	0.6 Msi	4.1 GPa
In Plane Shear Strength (+/-45)	ETW	ASTM D3518	11.6 ksi	80.0 MPa	11.5 ksi	79.3 MPa
In Plane Shear Modulus (+/-45)	ETW	ASTM D3518	0.41 Msi	2.3 GPa	0.6 Msi	4.1 GPa
ILSS 0°	RTD	ASTM D2344	19.3 ksi	133.1 MPa	18.8 ksi	129.6 MPa
ILSS 0°	ETD	ASTM D2344	13.5 ksi	93.1 MPa	12.8 ksi	88.3 MPa
ILSS 0°	ETW	ASTM D2344	7.8 ksi	53.8 MPa	6.4 ksi	44.1 MPa
CAI 1500 in-lb/in	RTD	ASTM D7137	32.0 ksi	220.6 MPa	N/A	N/A
Laminate DMA Onset Tg Dry			376°F	190.9°C	372°F	189°C
Laminate DMA Onset Tg Wet			297°F	147°C	293°F	145°C

(A) - Vacuum cure. Data Normalized to 60% fiber volume except ILSS.

- **ETD is 250°F (121°C); Cure A Used:** 1.5°F/min to 225°F for one hour, followed by 2°F/min to 350°F for 2.5 hours.

- **ETW is 250°F (121°C);** Conditioning - 85% RH at 160°F (71°C) until saturation.

(B) - **ETD is 250°F (121°C); Cure B Used:** 1.5°F/min to 225°F for one hour, followed by 2°F/min to 275°F for 3 hours. (Free standing post cure 350°F for 2 hours.)

- **ETW is 250°F (121°C);** Conditioning - 85% RH at 160°F (71°C) until saturation.

(C) Open Hole Compression Lay Up Sequence - **40 Plies:** (45/0/-45/90/45/0/-45/90/-45/90) **2S**

(D) Open Hole Tensile Lay Up Sequence - **32 Plies:** (45/0/-45/90) **4S**

### LAMINATE DATA USED AS-4C 3K 193 FAW PLAIN WEAVE FABRIC

The data below represents limited lot data.

Property	Condition	Method	Results	
Tensile Strength 0°	RTD	ASTM D3039	139 ksi	958.4 MPa
Tensile Modulus 0°	RTD	ASTM D3039	9 Msi	62.1 GPa
Tensile Strength 0°	ETD	ASTM D3039	146 ksi	1006.6 MPa
Tensile Modulus 0°	ETD	ASTM D3039	10.1 Msi	69.6 GPa
Tensile Strength 0°	ETW	ASTM D3039	127.1 ksi	876.3 MPa
Tensile Modulus 0°	ETW	ASTM D3039	9.9 Msi	68.3 GPa
Compressive Strength 0°	RTD	ASTM D695	126 ksi	868.7 MPa
Compressive Modulus 0°	RTD	ASTM D695	8.8 ksi	60.7 GPa
Compressive Strength 0°	ETD	ASTM D695	118 ksi	813.6 MPa

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TENCATE ADVANCED COMPOSITES

## TC350-1 Out-of-Autoclave Resin System

### LAMINATE DATA USED AS-4C 3K 193 FAW PLAIN WEAVE FABRIC

The data below represents limited lot data.

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Property	Condition	Method	Results	
Compressive Modulus 0°	ETD	ASTM D695	7.8 Msi	53.8 GPa
Compressive Strength 0°	ETW	ASTM D695	110.7 ksi	763.2 MPa
Compressive Modulus 0°	ETW	ASTM D695	8.4 Msi	579.1 GPa
Flexural Strength	RTD	ASTM D7264	159 ksi	1096.3 MPa
Flexural Modulus	RTD	ASTM D7264	8.2 Msi	56.5 GPa
Flexural Strength	ETD	ASTM D7264	144 ksi	992.9 MPa
Flexural Modulus	ETD	ASTM D7264	8.2 Msi	56.5 GPa
Flexural Strength	ETW	ASTM D7264	115.9 ksi	799.1 MPa
Flexural Modulus	ETW	ASTM D7264	7.7 Msi	53.1 GPa
ILSS 0°	RTD	ASTM D2344	13.3 ksi	91.7 MPa
ILSS 0°	ETD	ASTM D2344	11.3 ksi	77.9 MPa
ILSS 0°	ETW	ASTM D2344	9.2 ksi	63.4 MPa

- Vacuum cure. Data Normalized to 60% fiber volume except ILSS.

- **ETD is 200°F (93°C)**; Cure Used: 1.5°F/min to 225°F for one hour, followed by 2°F/min to 350°F for 2.5 hours.

- **ETW is 200°F (93°C)**; Conditioning - 85% RH at 160°F (71°C) until saturation.

### TenCate TC350-1 Alternate Fiber/Fabric Offerings

In addition to the data and products shown in the tables above, TenCate also provides these listed common fibers/fabrics with this resin system. Three lot mechanical data may also be available and the products below are provided on a regular basis.

If you have a unique request for a fiber/fabric not shown, please feel free to call us.

**Format: Fiber/Fabric, fiber areal weight (gsm), resin content %, width inches**

IM7 6K 4HS, 203 gsm, 40% RC, 50"

### 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 TenCate Advanced Composites (TCAC) 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 0°F (-18°C) 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 pin-hole in the bag or other problem occurs.

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## TC350-1 Out-of-Autoclave Resin System

### 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 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.

### NON-METALLIC HONEYCOMB AND FOAM CORE USE

When using Non-Metallic honeycomb and foam core materials for sandwich structures, the materials should always be dried in an oven prior to layup 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 re-hydration.

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

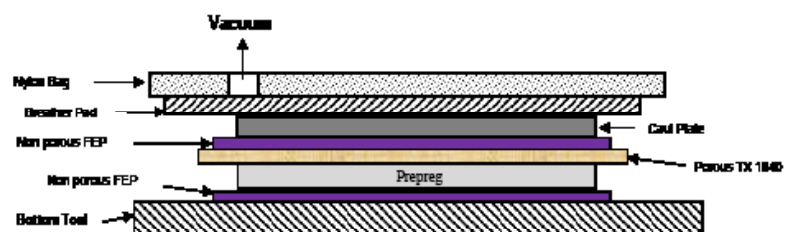
### DEBULK SEQUENCE FROM TOOL SURFACE TO BAGGING MATERIALS

- a. Bottom Tool
- b. Non porous FEP
- c. Prepreg
- d. Porous TX1040
- e. Non porous FEP
- f. Caul plate
- g. Breather (woven or thick breather)
- h. Vacuum bag
- i. Repeat above procedure

An excellent debulking procedure was necessary to minimize entrapped air between plies as shown in Figure 1. Pulled vacuum was at least at 27 in. Hg. TC350-1 system was debulked every 4 plies for 5-10 min. each until the needed plies for the sample was achieved. For TC350-1 woven fabric debulked were every 2 plies for 5-10 mins. An additional ply of porous Teflon coated glass(TX1040) was used to help the removal of entrapped air and it was replaced after being used for 2-3 times of debulking.

### 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 – 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 osy 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)



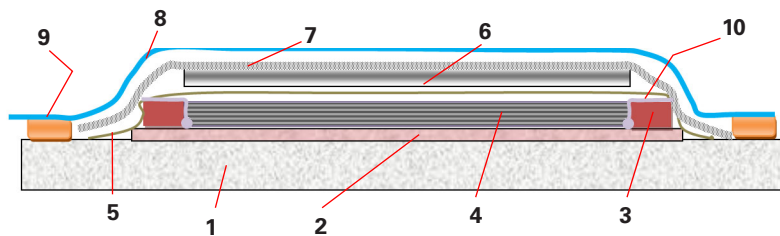
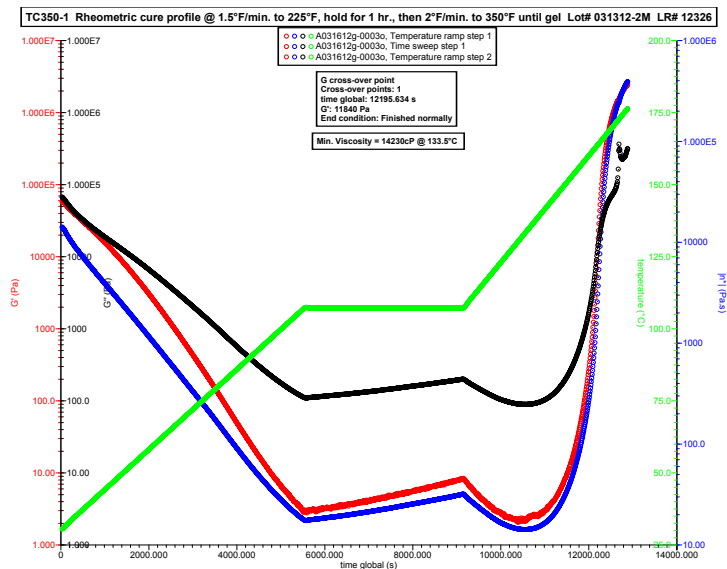
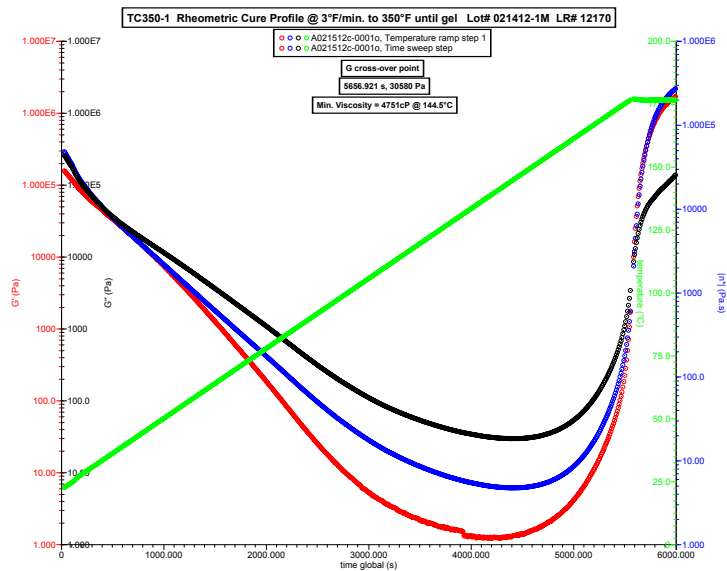
Debulk Sequence for TC350-1 Units and Fabric

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## TC350-1 Out-of-Autoclave Resin System



Final bagging sequence for TC350-1 Unitape & Fabric

Revised 07/2015

All data given is based on representative samples of the materials in question. Since the method and circumstances under which these materials are processed and tested are key to their performance, and TenCate Advanced Composites USA, Inc. has no assurance of how its customers will use the material, the corporation cannot guarantee these properties.

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### TENCATE ADVANCED COMPOSITES

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