Toray TC410

Toray Advanced Composites

PRODUCT DATA SHEET

DESCRIPTION

Toray TC410 is Toray's newest high performance cyanate ester resin system designed specifically for the latest generation of radomes and satellite structures. TC410 is unique in that it allows for low stress cures at 121°C (250°F) while achieving extremely low moisture absorption and high conversion levels. The lower cure temperature allows for lower stress in part fabrication. TC410 possesses all the key attributes for satellite use with good resistance to atomic radiation, low microcracking, and excellent resistance to process moisture. TC410 possesses low dielectric and loss tangents for radome usage.

FEATURES

- **Low stress-free cure temperature capable**
- **Low temperature cure for low stress-free part stability**
- **Passes and exceeds space requirements for outgassing**
- **Low CTE and CME**
- **Extremely low moisture absorption.**
- **Resin is asymptotic after 200 days with less than 0.35% moisture absorption in a 75% RH environment**
- **Good dielectric and loss tangent**

PRODUCT TYPE

121°C (250°F) Cure Toughened Cyanate Ester Resin System

TYPICAL APPLICATIONS

- Satellite structure
- Optical benches
- Reflectors
- High dimensional stability space structures
- Ideal for radomes and radar transparent structures

SHELF LIFE

Out Life:	Up to 7 days at ambient
Frozen Storage Life:	6 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 a 15 x 15 cm (6 x 6") laminate, cured in an autoclave. Users may need to separately evaluate out life limits on thicker, larger, and more complex parts.*

NEAT RESIN PROPERTIES

Density	1.16 g/cc 1.14 g/cc after 177°C (350°F) post cure	
Dry T_g by DMA	112°C (234°F) cured at 127°C (260°F)	
Wet T_g by DMA	123°C (253°F) cured at 127°C (260°F) conditioned at 71°C (160°F), 85% RH for 21 days	
Dry T_g by DMA	181°C (358°F) post cured at 177°C (350°F) for 2 hours	
Wet T_g by DMA	176°C (349°F) post cured at 177°C (350°F) for 2 hours conditioned at 71°C (160°F), 85% RH for 21 days	
Moisture Absorption	1.7% after 313 days at 71°C (160°F), 85% RH	
Outgassing (ASTM E595)[1]	TML CVCM WVR TML-WVR	0.29 % < 0.01% 0.17 % 0.12 %
Dimensional Stability[1]	CTE CME	32.475 µin/in/°F 1205 µin/in/%

[1] *Data provided by ITT Space Systems Division. See chart on the next page.*

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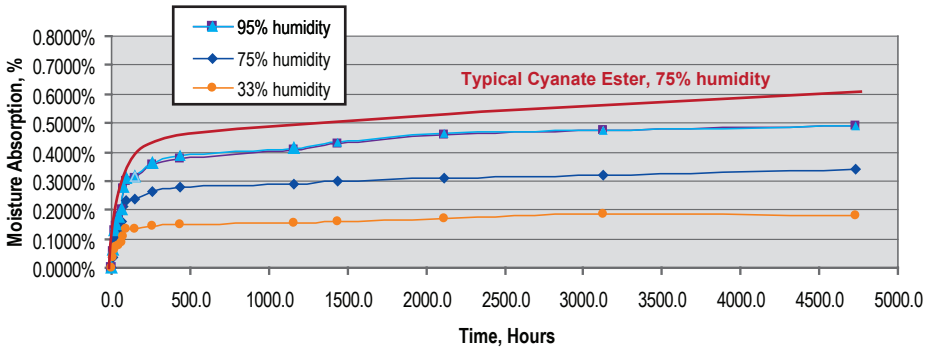
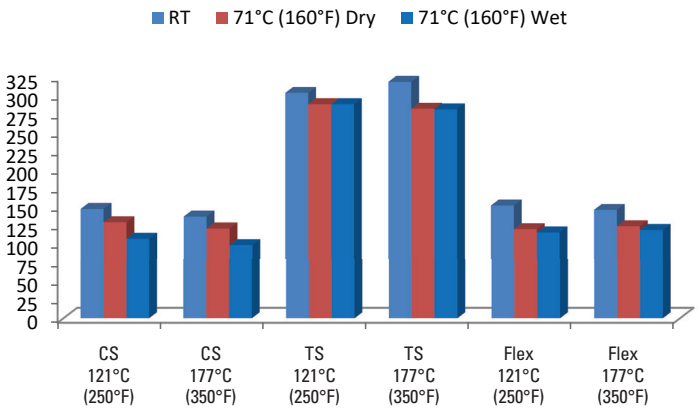
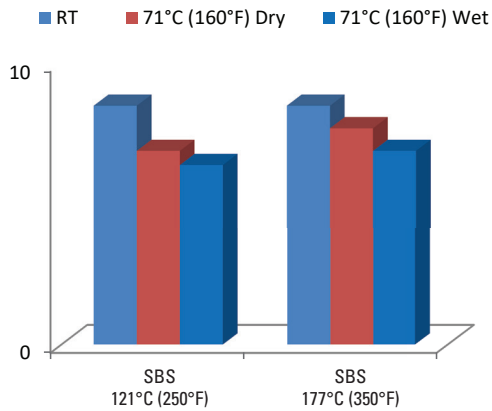


TC410 neat resin moisture absorption at room temperature at humidity soaks ranging from 33% to 95% demonstrating TC410's superior resistance to moisture uptake.

[1] Data provided by ITT Space Systems Division.

MECHANICAL PERFORMANCE M55J, 90gsm UD TAPE





TEST DETAILS

Cure temp. = 3 hours 121°C (250°F) cure
Cure temp. = 2 hours 177°C (350°F) cure
Wet Conditioning = 71°C (160°F), 85% RH for 21 days
Data normalized to 60% fiber volume

PRODUCT DATA SHEET

MECHANICAL PROPERTIES

Property	Condition	Method	Results (a)		Results (b)		Results (c)		Results (d)	
Tensile Strength 0°	RTD	ASTM D 3039	2201 MPa	319 ksi	2096 MPa	304 ksi	688 MPa	99 ksi	731 MPa	106 ksi
Tensile Modulus 0°	RTD	ASTM D 3039	307 GPa	45 Msi	269 GPa	39 Msi	22 GPa	3.2 Msi	28 GPa	4 Msi
Tensile Strength 0°	ETD	ASTM D 3039	1951 MPa	283 ksi	1993 MPa	289 ksi	578 MPa	84 ksi	669 MPa	97 ksi
Tensile Modulus 0°	ETD	ASTM D 3039	283 GPa	41 Msi	296 GPa	43 Msi	25 GPa	3.6 Msi	27 GPa	4 Msi
Tensile Strength 0°	ETW	ASTM D 3039	1944 MPa	282 ksi	2048 MPa	297 ksi	503 MPa	73 ksi	579 MPa	84 ksi
Tensile Modulus 0°	ETW	ASTM D 3039	324 GPa	47 Msi	310 GPa	45 Msi	23 GPa	3.3 Msi	28 GPa	4 Msi
Compression Strength 0°	RTD	ASTM D 6641	951 MPa	138 ksi	1020 MPa	148 ksi	725 MPa	105 ksi	577 MPa	84 ksi
Compression Modulus 0°	RTD	ASTM D 6641	323 GPa	47 Msi	317 GPa	46 Msi	30 GPa	4 Msi	28 GPa	4 Msi
Compression Strength 0°	ETD	ASTM D 6641	841 MPa	122 ksi	896 MPa	130 ksi	567 MPa	82 ksi	493 MPa	71 ksi
Compression Modulus 0°	ETD	ASTM D 6641	118 GPa	48 Msi	317 GPa	46 Msi	30 GPa	4 Msi	28 GPa	4 Msi
Compression Strength 0°	ETW	ASTM D 6641	689 MPa	100 ksi	745 MPa	108 ksi	546 MPa	79 ksi	492 MPa	71 ksi
Compression Modulus 0°	ETW	ASTM D 6641	307 GPa	45 Msi	345 GPa	50 Msi	29 GPa	4 Msi	27 GPa	4 Msi
Flexural Strength 0°	RTD	ASTM D 7264	1016 MPa	147 ksi	1055 MPa	153 ksi	727 MPa	106 ksi	814 MPa	118 ksi
Flexural Modulus 0°	RTD	ASTM D 7264	258 GPa	37 Msi	262 GPa	38 Msi	21 GPa	3 Msi	25 GPa	3.7 Msi
Flexural Strength 0°	ETD	ASTM D 7264	862 MPa	125 ksi	834 MPa	121 ksi	634 MPa	92 ksi	652 MPa	95 ksi
Flexural Modulus 0°	ETD	ASTM D 7264	255 GPa	37 Msi	262 GPa	38 Msi	21 GPa	3 Msi	25 GPa	3.6 Msi
Flexural Strength 0°	ETW	ASTM D 7264	827 MPa	120 ksi	800 MPa	116 ksi	596 MPa	86 ksi	708 MPa	103 ksi
Flexural Modulus 0°	ETW	ASTM D 7264	248 GPa	36 Msi	TBD		21 GPa	3 Msi	24 GPa	3.5 Msi

Continued on page 4

MECHANICAL PROPERTIES

Continued from page 3

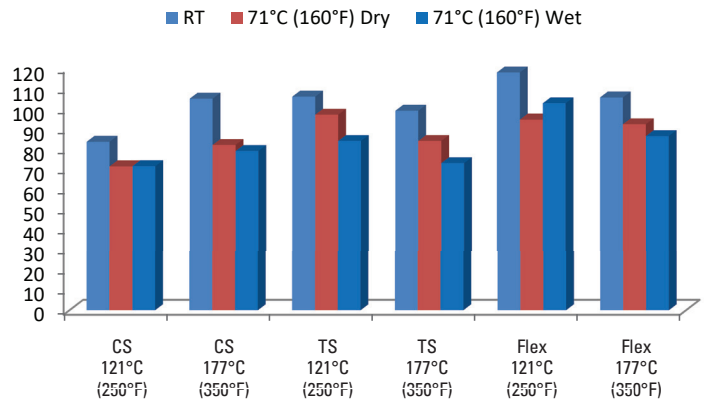
Property	Condition	Method	Results (a)		Results (b)		Results (c)		Results (d)	
Interlaminar Shear Strength SBS 0°	RTD	ASTM D 2344	58 MPa	8.5 ksi	58 MPa	8.5 ksi	63 MPa	9 ksi	58 MPa	8.5 ksi
Interlaminar Shear Strength SBS 0°	ETD	ASTM D 2344	53 MPa	7.7 ksi	48 MPa	6.9 ksi	54 MPa	8 ksi	43 MPa	6.2 ksi
Interlaminar Shear Strength SBS 0°	ETW	ASTM D 2344	47 MPa	6.9 ksi	44 MPa	6.4 ksi	48 MPa	7 ksi	46 MPa	6.6 ksi

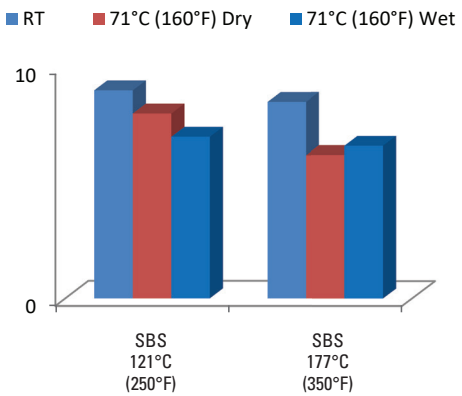
(a) Laminate Type: Toray M55J, 90gsm, 0°, uni-directional tape
Cure Parameters: Autoclave cure at 85 psi, 3 hours at 121°C (250°F). Post cure is 177°C (350°F) for 2 hours
ETD is 71°C (160°F). ETW is 71°C (160°F), 85% RH, 21 days. Data normalized to 55% fiber volume
(b) Laminate Type: Toray M55J, 90gsm, 0°, uni-directional tape
Cure Parameters: Autoclave cure at 85 psi, 3 hours at 121°C (250°F). Data normalized to 55% fiber volume
(c) Laminate Type: Astroquartz 4581 AQ III, FAW 284gsm, 38 ± 3% resin content
Cure Parameters: Autoclave cure at 100 psi, 3 hours at 121°C (250°F). Post cure is 177°C (350°F) for 2 hours
Toray M55J provided by ITT Space Systems Division
(d) Laminate Type: Astroquartz 4581 AQ III, FAW 284gsm, 38 ± 3% resin content
Cure Parameters: Autoclave cure at 100 psi, 3 hours at 121°C (250°F)

LAMINATE T_gs ON QUARTZ LAMINATES

Dry T_g by DMA with 121°C (250°F) cure for 3 hours	116°C (241°F)
Dry T_g by DMA with 177°C (350°F) post cure for 2 hours	179°C (354°F)
Wet T_g by DMA with 121°C (250°F) cure	113°C (235°F)
Wet T_g by DMA with 177°C (350°F) post cure	169°C (336°F)

MECHANICAL PERFORMANCE ON 4581 AQIII FABRIC





TEST DETAILS

Cure temp. = 3 hours 121°C (250°F) cure
Cure temp. = 2 hours 177°C (350°F) cure
Wet Conditioning = 71°C (160°F), 85% RH for 21 days
Data normalized to 55% fiber volume

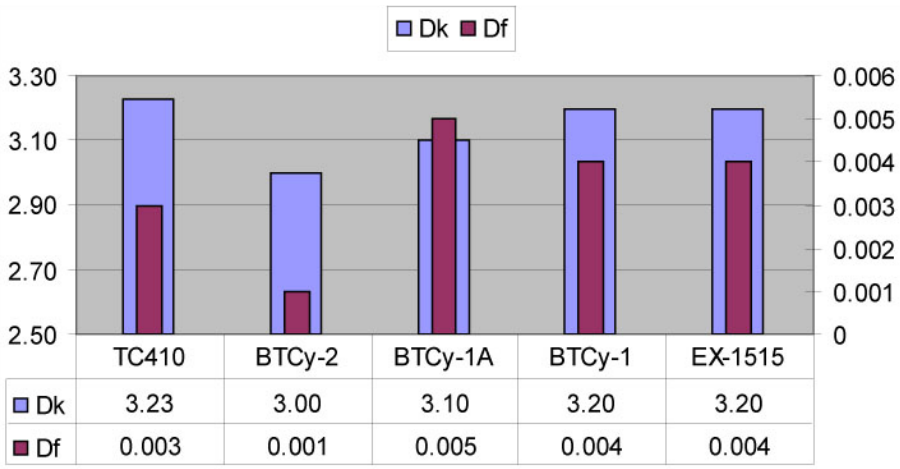
DIELECTRIC DATA ON QUARTZ LAMINATE AT 10 GHZ

Property	Method	Results	
		177°C (350°F) Cure	121°C (250°F) Cure
Dielectric Constant (Dk)	ASTM D 2520	3.23	3.26
Loss Tangent (Df)	ASTM D 2520	0.0034	0.0057

CURE SCHEDULE

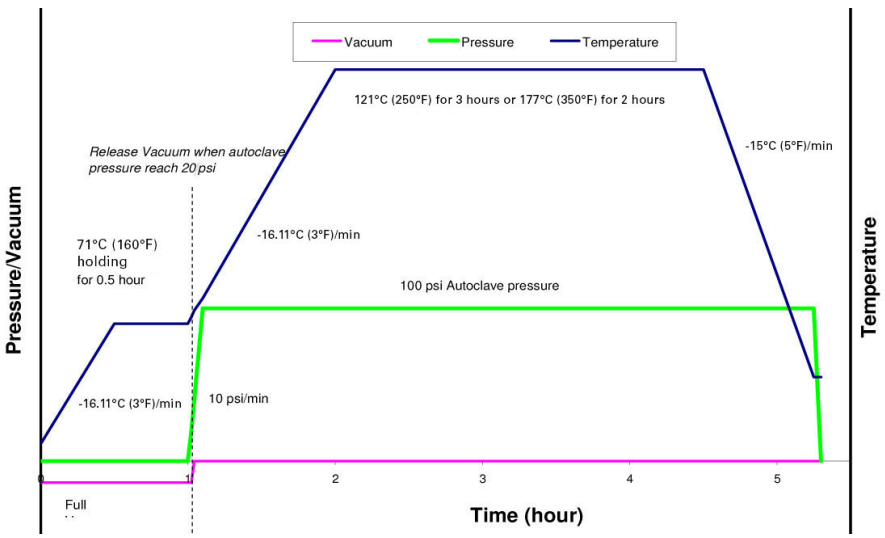
3 hours at 121°C (250°F) optional post cure at 177°C (330°F) for 2 hours for higher T_g cure pressure ramp rate

DIELECTRIC COMPARISON BETWEEN TORAY PRODUCTS



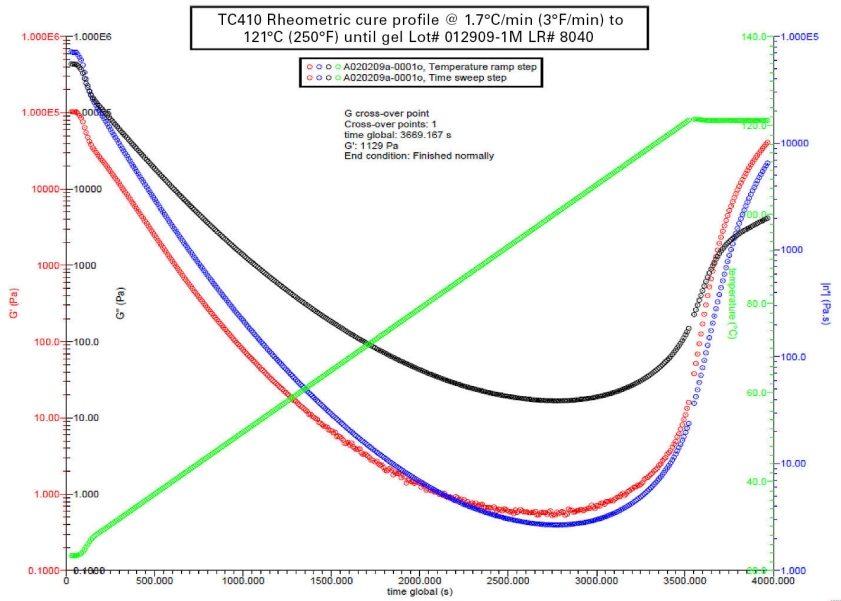
	TC410	BTCy-2	BTCy-1A	BTCy-1	EX-1515
Dk	3.23	3.00	3.10	3.20	3.20
Df	0.003	0.001	0.005	0.004	0.004

CURING PROFILE



PRODUCT DATA SHEET

DYNAMIC VISCOSITY



Temperature profile: 1.7°C/min (3°F/min) to 121°C (250°F), holding until gel

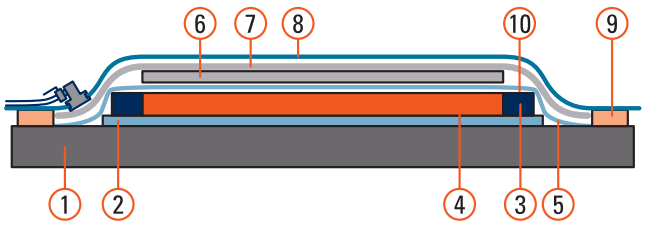
TYPICAL COMPOSITE LAMINATE STACKING SEQUENCE

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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