3960 Prepreg System Data Sheet

'TORAY'
Toray Composite Materials America, Inc.

PRODUCT NOTES

Toray's next-generation 3960 prepreg system demonstrates the next leap in performance of aerospace materials. Complementary pairing of the 3960 resin system with state-of-the-art TORAYCA™ T1100G carbon fiber provides the unparalleled properties expected of materials for the future. High toughness, exceptional tensile performance, and retention of hot/wet performance to 250°F (121°C), including a fast-cure system (3960-FC) that reduces cure time by up to 45%, make the 3960 system the clear choice for the future demands of the aerospace industry.

High Heat Tolerance

High Tg and hot/wet performance enable retention of critical properties like open-hole compression to 250°F (121°C) without compromising material toughness.

Resin Chemistry

System features synergy with T1100G, capturing fiber's full capability and maximizing translation of carbon fiber strand strength.

Flexible Cure Methods

Proven flexibility in curing and consistency in mechanical properties has been achieved by oven cure and autoclave, with or without an intermediate dwell.

Laminate Toughness

Toray's proven interlayer toughening technology sets the standard for laminate impact resistance and fracture toughness.

Flexible Processing

Prepreg can be suitably processed in either AFP or hand lay-up methodologies.

Fast-Cure System

Available fast-cure formulation (3960-FC) speeds cure time by to 45% compared to 3960 autoclave cure.

AVAILABLE PRODUCT FORMATS

3960 resin is available with numerous types of unidirectional carbon fibers and woven and glass fabrics with Fiber Areal Weight (FAW) ranging from 70 g/m^2 to 300 g/m^2 and Resin Content, (RC%) by weight percent, ranging from 33.5% to 45%. Unidirectional products can be slit to widths between 1/8" and 60", and fabric products to widths above 6". Common product formats include: 1/4", 1/2", and 1.5" AFP spools (UD only); 6", 9", and 12" ATL rolls; and 24" to full width rolls for hand layup.

PART NUMBER	FIBER FORMAT	FIBER TYPE/STYLE	FAW (GSM)	RC % WEIGHT	ROLL WIDTH (IN)
P173E2N-145	Unidirectional	T1100G-24K	145	35	Up to 39
P173EBN-19 per NMS 397/1	Unidirectional	T1100G-24K	192	33.5	Up to 60
FT6243R-3EF per NMS 397/2	Spread Plain Weave	T1100G-12K	196	35	Up to 60
P173E0N-7	Unidirectional	T1100G-12K	70	40	Up to 39
FT9222R-3EF	±45° 2x2T Bias Fabric	T1100G-12K	196	35	Up to 60
P173MBN-19 using 3960-FC	Unidirectional	T1100G-24K	192	33.5	Up to 60
FT6243R-3MF using 3960-FC	Spread Plain Weave	T1100G-12K	196	35	Up to 60

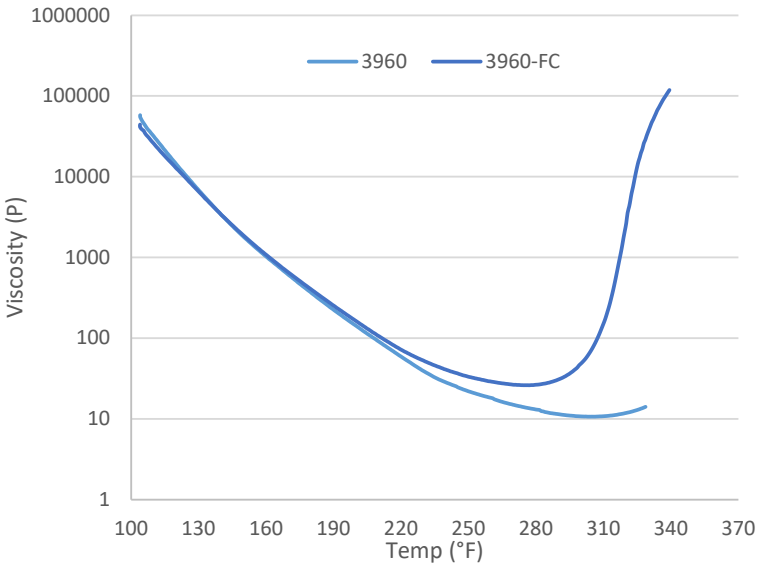
STORAGE LIFE

Out Time (Mechanical Life)	42 days @ < 77°F (25°C)
Freezer Life	3 years @ < 10°F (-12°C)

NEAT RESIN PHYSICAL PROPERTIES

PROPERTY	METHOD	UNITS	VALUE
Density	ASTM D792	g/cm3	1.274
Dry Tg	ASTM D7028	°F (°C)	395 (202)
Wet Tg	ASTM D7028	°F (°C)	334 (168)
Minimum Viscosity @ 3.6°F (2°C)/min (3960)	ASTM D4440	Poise @ °F (°C)	11.2 @ 309 (154)
Minimum Viscosity @ 3.6°F (2°C)/min (3960-FC)	ASTM D4440	Poise @ °F (°C)	26.1 @ 276 (135)

RESIN VISCOSITY CURVE



LAMINA/LAMINATE MECHANICAL PROPERTIES: P173E2N-145 (T1100G UD/Gr 145)

PROPERTY	SYMBOL	METHOD	UNITS	AUTOCLAVE CURE		
				CTA	RTA	ETW[1]
0° Tensile Strength	F_{1t}	ASTM D3039	Ksi (MPa)	552 (3807)	535 (3687)	540 (3726)
0° Tensile Modulus	E_{1t}	ASTM D3039	Msi (GPa)	23.8 (164)	23.6 (163)	24.1 (166)
0° Compressive Strength	F_{1C}	ASTM D6641	Ksi (MPa)	-	287 (1977)	-
0° Compressive Modulus	E_{1C}	ASTM D6641	Msi (GPa)	21.2 (146)	21.5 (148)	21.7 (150)
In-Plane Shear Strength @ 5%	$F_{12\ @\ 5\%}$	ASTM D5379	Ksi (MPa)	-	13.0 (90)	-
In-Plane Shear Modulus	G_{12}	ASTM D5379	Msi (GPa)	-	0.773 (5.33)	-
Short Beam Strength	SBS	ASTM D2344	Ksi (MPa)	-	16.8 (115.8)	-
Open Hole Compression Strength (QI: 25/50/25)	OHC	ASTM D6484	Ksi (MPa)	55.3 (381)	48.4 (334)	42.9 (296)
Compression After Impact (QI: 25/50/25)	CAI	ASTM D7137	Ksi (MPa)	-	47.8 (330)	-
Laminate Density	ρ	ASTM D792	g/cm³	1.567		
Fiber Volume	V_F	ASTM D3171	%	56.6		
Cured Ply Thickness	CPT	ASTM D3171	In. (mm)	0.0057 (0.145)		

Notes:
CTA: -65°F/-54°C, as-received
RTA: 72°F/22°C, as-received
ETW1: 180°F/82°C, equilibrium conditioned
ETW2: 250°F/121°C, equilibrium conditioned

LAMINA/LAMINATE MECHANICAL PROPERTIES: P173EBN-19 (T1100G UD/Gr 192)

PROPERTY	SYMBOL	METHOD	UNITS	AUTOCLAVE CURE				OVEN CURE		
				CTA	RTA	ETW[1]	ETW[2]	RTA	ETW[1]	ETW[2]
0° Tensile Strength	F_{1t}	ASTM D3039	Ksi (MPa)	548 (3778)	548 (3778)	535 (3689)	490 (3378)	537 (3702)	-	-
90° Tensile Strength	F_{2t}	ASTM D3039	Ksi (MPa)	9.19 (63.4)	9.90 (68.3)	5.30 (36.5)	3.62 (25.0)	8.62 (59.4)	-	-
0° Tensile Modulus	E_{1t}	ASTM D3039	Msi (GPa)	25.1 (173)	24.9 (172)	24.6 (170)	24.2 (167)	24.5 (169)	-	-
90° Tensile Modulus	E_{2t}	ASTM D3039	Msi (GPa)	1.46 (10.1)	1.34 (9.24)	1.13 (7.79)	0.70 (4.83)	1.31 (9.03)	-	-
0° Compressive Strength (Backed Out)	F_{1C}	ASTM D6641	Ksi (MPa)	314 (2165)	299 (2062)	274 (1889)	200 (1379)	-	-	-
90° Compressive Strength	F_{2C}	ASTM D6641	Ksi (MPa)	50.4 (347)	37.5 (259)	23.7 (163)	16.0 (110)	-	-	-
0° Compressive Modulus	E_{1C}	ASTM D6641	Msi (GPa)	22.6 (156)	22.2 (153)	22.7 (157)	22.5 (155)	-	-	-
90° Compressive Modulus	E_{2C}	ASTM D6641	Msi (GPa)	1.58 (10.9)	1.39 (9.58)	1.27 (8.76)	1.02 (7.03)	-	-	-
In-Plane Shear Strength @ 5%	$F_{12\ @\ 5\%}$	ASTM D5379	Ksi (MPa)	19.6 (135)	15.5 (107)	9.85 (67.9)	6.42 (44.3)	-	-	-
In-Plane Shear Modulus	G_{12}	ASTM D5379	Msi (GPa)	0.92 (6.34)	0.78 (5.38)	0.57 (3.93)	0.38 (2.62)	0.80 (5.52)	-	-
Short Beam Strength	SBS	ASTM D2344	Ksi (MPa)	22.5 (155)	16.5 (114)	10.8 (74.5)	6.85 (47.2)	17.0 (117)	10.8 (74.5)	6.9 (47.6)
Open Hole Compression Strength (QI: 25/50/25)	OHC	ASTM D6484	Ksi (MPa)	-	48.8 (336)	43.1 (297)	35.7 (246)	47.0 (324)	41.2 (284)	36.5 (252)
"Compression After Impact @ 1500in-lb/in (QI: 25/50/25)"	CAI	ASTM D7137	Ksi (MPa)	-	49.1 (339)	-	-	43.4 (299)	-	-
Laminate Density	ρ	ASTM D792	g/cm^3	1.573				1.570		
Fiber Volume	V_F	ASTM D3171	%	57.9				56.5		
Cured Ply Thickness	CPT	ASTM D3171	In. (mm)	0.0072 (0.183)						

Notes:
CTA: -65°F/-54°C, as-received
RTA: 72°F/22°C, as-received
ETW1: 180°F/82°C, equilibrium conditioned
ETW2: 250°F/121°C, equilibrium conditioned

LAMINA/LAMINATE MECHANICAL PROPERTIES: FT6243R-3EF (T1100G-12K PW)

PROPERTY	SYMBOL	METHOD	UNITS	AUTOCLAVE CURE				OVEN CURE		
				CTA	RTA	ETW[1]	ETW[2]	CTA	RTA	ETW[2]
0° Tensile Strength	F_{1t}	ASTM D3039	Ksi (MPa)	227 (1565)	241 (1662)	259 (1786)	263 (1813)	-	-	-
90° Tensile Strength	F_{2t}	ASTM D3039	Ksi (MPa)	221 (1524)	223 (1538)	239 (1648)	227 (1565)	213 (1469)	208 (1434)	-
0° Tensile Modulus	E_{1t}	ASTM D3039	Msi (GPa)	12.3 (84.9)	12.7 (87.8)	12.5 (86.3)	12.3 (85.1)	-	-	-
90° Tensile Modulus	E_{2t}	ASTM D3039	Msi (GPa)	12.5 (86.2)	12.4 (85.5)	12.6 (86.9)	12.2 (84.1)	12.6 (86.9)	12.5 (86.2)	-
0° Compressive Strength	F_{1C}	ASTM D6641	Ksi (MPa)	134 (924)	123 (848)	107 (738)	75.0 (517)	-	-	-
90° Compressive Strength	F_{2C}	ASTM D6641	Ksi (MPa)	131 (903)	120 (827)	99.6 (687)	66.5 (459)	-	126 (869)	75.2 (518)
0° Compressive Modulus	E_{1C}	ASTM D6641	Msi (GPa)	11.6 (80.0)	11.3 (77.9)	11.6 (80.0)	11.7 (80.7)	-	-	-
90° Compressive Modulus	E_{2C}	ASTM D6641	Msi (GPa)	11.4 (78.6)	11.3 (77.9)	11.4 (78.6)	11.7 (80.7)	-	10.4 (71.7)	12.9 (88.9)
In-Plane Shear Strength @ 5%	$F_{12\ @\ 5\%}$	ASTM D5379	Ksi (MPa)	22.4 (154)	16.5 (114)	11.3 (77.9)	7.36 (50.8)	-	-	-
In-Plane Shear Modulus	G_{12}	ASTM D5379	Msi (GPa)	0.85 (5.86)	0.75 (5.17)	0.59 (4.07)	0.40 (2.76)	-	-	-
Short Beam Strength	SBS	ASTM D2344	Ksi (MPa)	14.8 (102)	12.5 (86.2)	8.51 (58.7)	4.43 (30.5)	-	10.9 (75.2)	4.3 (29.6)
Open Hole Compression Strength (QI: 25/50/25)	OHC	ASTM D6484	Ksi (MPa)		46.8 (323)	41.9 (289)	36.0 (248)	-	47.9 (330)	36.4 (251)
Compression After Impact (QI: 25/50/25)	CAI	ASTM D7137	Ksi (MPa)		43.3 (299)			-	41.5 (286)	-
Laminate Density	ρ	ASTM D792	g/cm^3	1.570				1.560		
Fiber Volume	V_F	ASTM D3171	%	56.9				56.2		
Cured Ply Thickness	CPT	ASTM D3171	In. (mm)	0.0076						

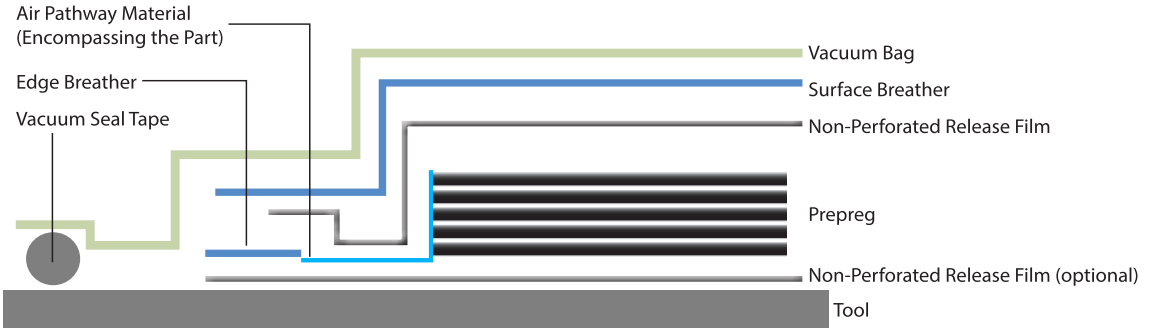
Notes:
CTA: -65°F/-54°C, as-received
RTA: 72°F/22°C, as-received
ETW1: 180°F/82°C, equilibrium conditioned
ETW2: 250°F/121°C, equilibrium conditioned

LAMINA/LAMINATE MECHANICAL PROPERTIES: P173E0N-7 (T1100G UD/Gr 70)

PROPERTY	SYMBOL	METHOD	UNITS	AUTOCLAVE CURE			
				CTA	RTA	ETW[1]	ETW[2]
0° Tensile Strength	F_{1t}	ASTM D3039	Ksi (MPa)	468 (3227)	476 (3282)	-	-
90° Tensile Strength	F_{2t}	ASTM D3039	Ksi (MPa)	9.70 (66.9)	10.3 (71.0)	-	-
0° Tensile Modulus	E_{1t}	ASTM D3039	Msi (GPa)	22.8 (157)	22.5 (155)	-	-
90° Tensile Modulus	E_{2t}	ASTM D3039	Msi (GPa)	1.30 (8.96)	1.20 (8.27)	-	-
0° Compressive Strength	F_{1C}	ASTM D6641	Ksi (MPa)	201 (1382)	201 (1387)	-	-
90° Compressive Strength	F_{2C}	ASTM D6641	Ksi (MPa)	48.8 (336)	36.8 (254)	-	-
0° Compressive Modulus	E_{1C}	ASTM D6641	Msi (GPa)	19.5 (134)	19.4 (134)	-	-
90° Compressive Modulus	E_{2C}	ASTM D6641	Msi (GPa)	1.40 (9.65)	1.30 (8.96)	-	-
In-Plane Shear Strength @ Ult.	F_{12}	ASTM D5379	Ksi (MPa)	18.6 (128)	13.8 (95)	-	-
In-Plane Shear Modulus	G_{12}	ASTM D5379	Ksi (MPa)	0.80 (5.5)	0.60 (4.1)	-	-
Short Beam Strength	SBS	ASTM D2344	Ksi (MPa)	20.7 (143)	15.4 (106)	-	-
Open Hole Compression Strength (QI: 25/50/25)	OHC	ASTM D6484	Ksi (MPa)	52.1 (359)	45 (310)	41.6 (287)	37.1 (256)
Laminate Density	ρ	ASTM D792	g/cm^3	1.520			
Fiber Volume	V_F	ASTM D3171	%	50.9			
Cured Ply Thickness	CPT	ASTM D3171	In. (mm)	0.0029 (0.074)			

Notes:
CTA: -65°F/-54°C, as-received
RTA: 72°F/22°C, as-received
ETW1: 180°F/82°C, equilibrium conditioned
ETW2: 250°F/121°C, equilibrium conditioned

BAGGING PROCEDURE

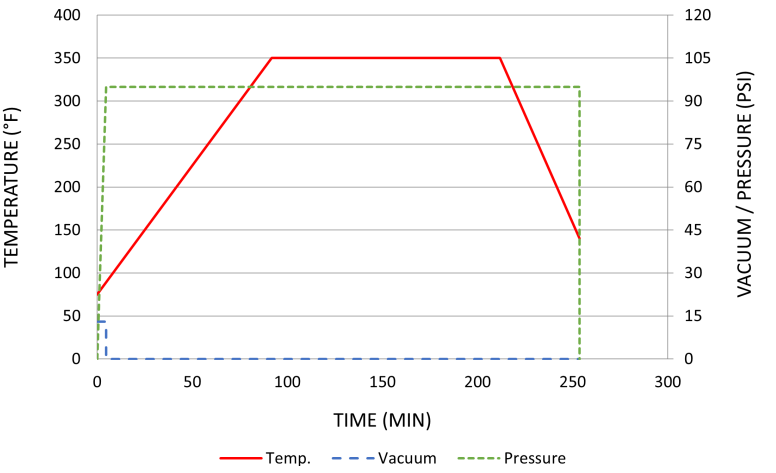


Notes:
1. During layup, debulk after the first ply and then every 4 plies or as needed.
2. The vacuum should be checked for leaks before beginning the cure cycle. The leak rate shall be less than 2.0 inches of Hg (7 kPa) over 5 minutes.

Please refer to the SDS for handling and disposal.

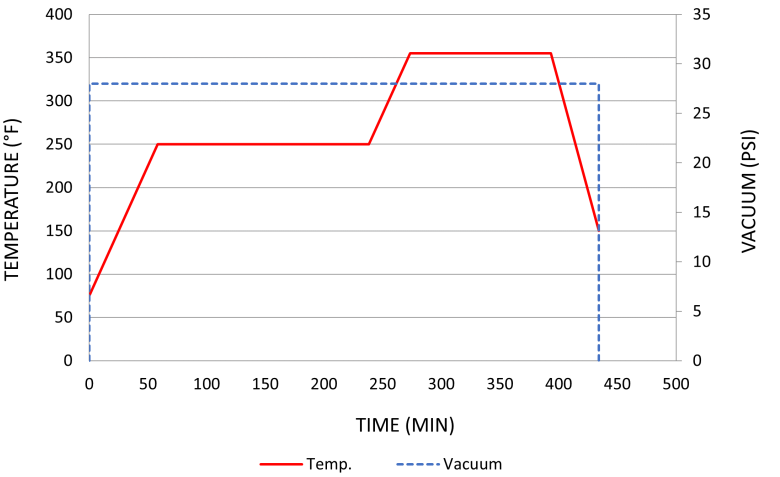
CURE CYCLE - AUTOCLAVE

1. Apply full vacuum* to the part.
2. Apply 85 +15/-0 psi (586 +100/-0 kPa) autoclave pressure.
3. Vent the vacuum bag when the autoclave pressure reaches 20psi (138kPa).
4. Ramp to 355 ± 10°F (180 ± 5°C) at a rate of 3.0 ± 2.0°F (1.7 ± 1.1°C) per minute.
5. Hold for 120 - 180 minutes at 355 ± 10°F (180 ± 5°C)
6. Cool vessel to 140°F (60°C) or lower at a maximum rate of 5°F (2.8°C) per minute before releasing autoclave pressure.



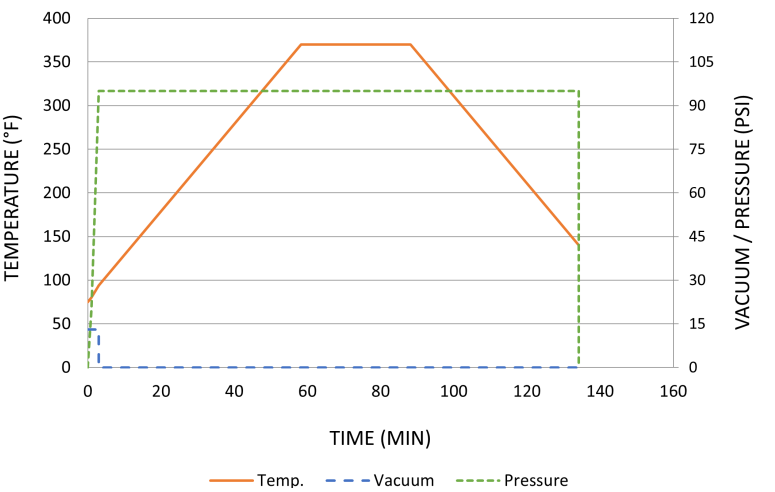
CURE CYCLE - OVEN

1. Apply full vacuum* to the part. Maintain vacuum for at least three hours prior to beginning cure cycle is recommended for optimal part quality.
2. Ramp to 250 ± 10°F (121 ± 5°C) at a rate of 3.0 ± 2.0°F (1.7 ± 1.1°C) per minute.
3. Hold for 180 minutes at 250 ± 10°F (121 ± 5°C)
4. Ramp to 355 ± 10°F (180 ± 5°C) at a rate of 3.0 ± 2.0°F (1.7 ± 1.1°C) per minute.
5. Hold for 120 - 180 minutes at 355 ± 10°F (180 ± 5°C)
6. Cool vessel to 140°F (60°C) or lower at a maximum rate of 5°F (2.8°C) per minute before releasing autoclave pressure.



CURE CYCLE - 3960-FC

1. Apply full vacuum* to the part.
2. Apply 85 +15/-0 psi (586 +100/-0 kPa) autoclave pressure.
3. Vent the vacuum bag when the autoclave pressure reaches 20psi (138kPa).
4. Ramp to 370 ± 10°F (188 ± 5°C) at a rate of 5.0 +2°F (2.8 ± 1.1°C) per minute.
5. Hold for 30 minutes (minimum) at 370 ± 10°F (188 ± 5°C)
6. Cool vessel to 140°F (60°C) or lower at a maximum rate of 5°F (2.8°C) per minute before releasing autoclave pressure.



*Ensure vacuum is within 2inHg of atmospheric pressure

The data listed herein are lot averages, for reference purposes only, and are offered AS-IS without warranty.
WARNING - This message and any attachments may contain Controlled Technology, of which export is restricted by the Export Administration Act of 1979, as amended, Title 50, U.S.C., App. 2401 et seq. Violations of Export Control laws and regulations may be subject to severe penalties.