

4000 Prepreg System Data Sheet



Toray Composite Materials America, Inc.

PRODUCT NOTES

4000 prepreg system features a toughened bismaleimide (BMI) resin system specifically formulated for aircraft primary structures demanding enhanced strength and toughness in high service temperature environments up to 450°F (232°C). When compared to other BMI prepregs on the market, Toray's 4000 prepreg system outperforms the competition while maintaining the familiar handling and flow characteristics of traditional epoxy prepregs.

PRODUCT SPECIFICATIONS

The 4000 prepreg system has been tested using the following product forms, however customized configurations are possible with numerous types of TORAYCA™ unidirectional carbon fibers, woven carbon, or glass fabrics. Fiber Areal Weights (FAW) can range from 70 g/m² to 300 g/m² while Resin Content (RC %) by weight percent typically ranges from 24% to 40%. Requests for configurations beyond these ranges are possible.

Unidirectional products can be slit to widths between 1/8" and 60", and fabric products to widths between 6" and 60". Common product formats include 1/4", 1/2", 1", and 1.5" AFP spools (UD only); 6", 500mm, 9", and 12" ATL rolls; and 24" to full-width rolls for hand layup. Product widths narrower than 3" require additional lead time.

PREPREG DESCRIPTION	RESIN CONTENT (WT%)	FAW (G/M ²)	AVAILABLE WIDTHS	CURED PLY THICKNESS
Carbon UD Tape (T800G-24K-F1E/4000)	35	145	1/8 to 60in (3 – 1524mm)	0.0058in (0.147mm)
Carbon UD Tape (T1100G-12K-F1E/4000)	35	145	1/8 to 60in (3 – 1524mm)	0.0057in (0.145mm)

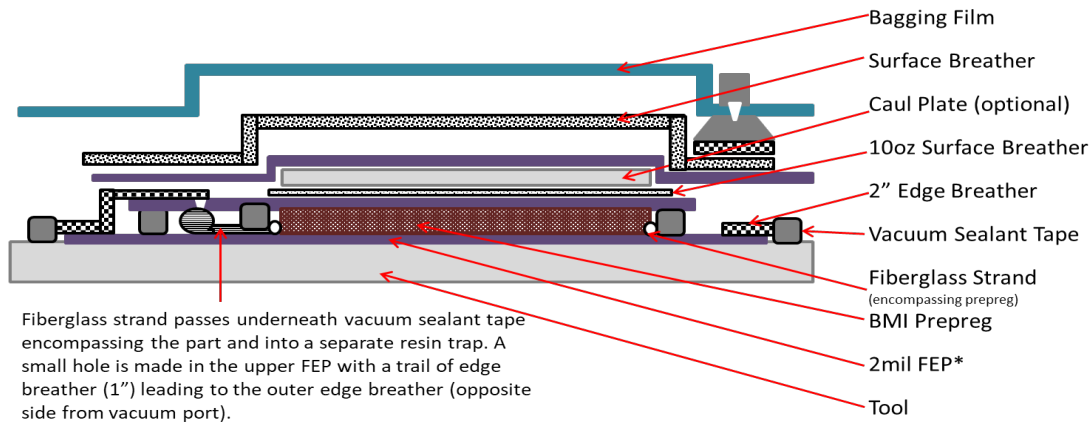
HANDLING AND STORAGE LIFE

STORAGE CONDITION	TIME	NOTES
< 10°F (-12°C)	12 Months	Keep in sealed container until thawed
10 – 85°F (-12 – 30°C)	14 Days	Tack may be increased by increasing temperature; please contact us for more information

NEAT RESIN DATA

TEST TYPE	METHOD	VALUE	NOTES
Density	ASTM D595	1.272 g/cm ³	-
Gel Time	ASTM D3532	13 minutes	Tested at 350°F (177°C)
Cured Tg	ASTM D7028	Dry: 484°F (251°C) Wet: 453°F (234°C)	Wet conditioning: H2O soak at 208°F (98°C) for 24 hours

BAGGING SCHEME

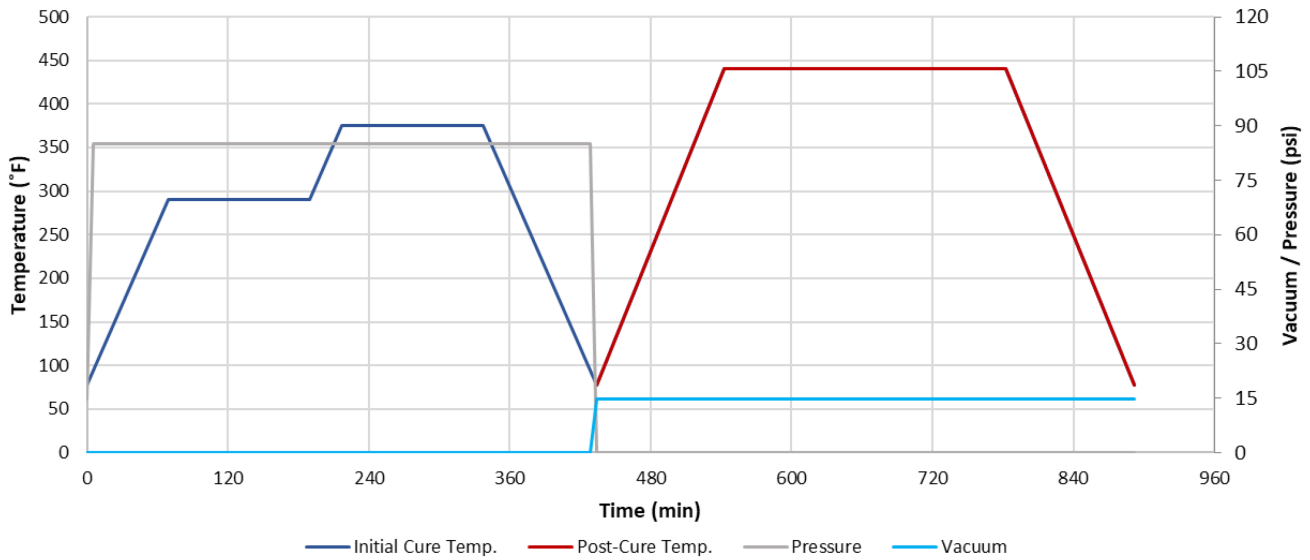


*FEP is optional if the tool/mold is coated with a release agent

Note: The double bag scheme illustrated above is the recommended technique for 4000 prepreg system, however traditional bagging methods used for epoxy prepreg systems may be compatible. Please contact Toray CMA for information.

- The FEP between the tool surface and the part (if used) needs to be stretched tight to prevent surface defects.
- The fiberglass strand wrapped around the prepreg should be pressed tightly against the side of the prepreg.
- The distance between the edge of the prepreg and the sealant tape should be at least 1.75 mm.
- The FEP between the prepreg and the caul plate (if used) should have no wrinkles on the portion contacting the prepreg. It should also cover the resin trap. A small hole should be made in the FEP above the coiled fiberglass in the resin trap.
- A 10 oz surface breather is placed between the caul plate and the FEP to prevent the caul plate from puncturing the FEP.
- If post-cure will immediately follow initial cure, please ensure bagging materials and autoclave hosing are rated for the post-cure cycle's max temperature of $440 \pm 10^{\circ}\text{F}$ ($227 \pm 5^{\circ}\text{C}$).

STANDARD CURE CYCLE



Note: This resin system requires a high-temperature post-cure to obtain optimal mechanical performance. Alternate post-cure temperatures and hold times may be used to tune the system's Tg and toughness properties; please contact Toray CMA for more information.

Initial Cure Steps

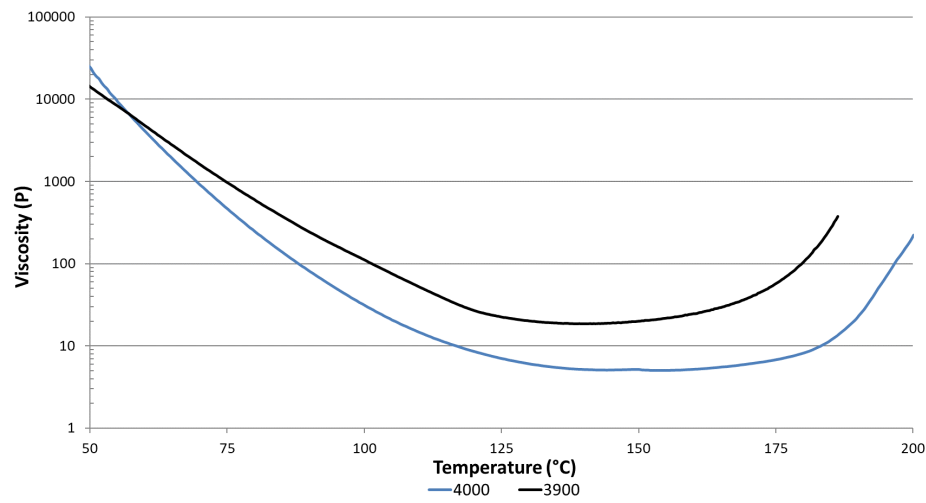
1. De-bulk every four plies, or as needed, when laying up material.
2. Apply full vacuum* to the part. The vacuum should be checked for leaks before beginning the cure cycle. The leak rate shall be less than 1 psi over 5 minutes.
3. Apply 85 ± 0 psi autoclave pressure to the laminate.
4. Ramp to $290 \pm 10^\circ\text{F}$ at $3^\circ\text{F}/\text{min}$ ($143 \pm 5^\circ\text{C}$ at $1.7^\circ\text{C}/\text{min}$) and hold for 120 minutes.
5. Ramp to $375 \pm 10^\circ\text{F}$ at $3^\circ\text{F}/\text{min}$ ($191 \pm 5^\circ\text{C}$ at $1.7^\circ\text{C}/\text{min}$) and hold for 120 minutes.
6. Cool temperature down to 77°F at max rate of $3^\circ\text{F}/\text{min}$ (77°C at $1.7^\circ\text{C}/\text{min}$) and vent/release autoclave and vacuum pressure.

Post-Cure Steps

1. The post-cure cycle may be initiated immediately after the initial cure's cooldown step provided that the bagging materials and autoclave hosing are rated to withstand 440°F (227°C), or free-standing in an air-circulating oven.
2. Ramp to $440 \pm 10^\circ\text{F}$ at $3^\circ\text{F}/\text{min}$ ($227 \pm 5^\circ\text{C}$ at $1.7^\circ\text{C}/\text{min}$) and hold for 240 minutes.
3. Cool temperature down to 77°F at max rate of $3^\circ\text{F}/\text{min}$ (77°C at $1.7^\circ\text{C}/\text{min}$).

*Required vacuum level varies depending on elevation. 13.78 psi is the recommended minimum at sea level under average conditions.

RESIN VISCOSITY CURVE



MECHANICAL PROPERTIES – STANDARD CURE & POST-CURE

TEST TYPE		TEST METHOD	TEST CONDITION	T800G UD		T1100G UD	
0° Tension*	Strength: Ksi (MPa)	ASTM D3039	CTA	395	(2723)	456	(3145)
			RTA	413	(2845)	460	(3174)
			ETW 180°F	419	(2885)	502	(3463)
			ETA	411	(2832)	479	(3300)
	Modulus: Msi (GPa)	ASTM D3039	CTA	23.7	(163)	26.4	(182)
			RTA	22.8	(157)	26.1	(180)
			ETW 180°F	22.5	(155)	26.1	(180)
			ETA	22.8	(157)	25.7	(177)
0° Combined Loadin Compression (CLC)* (T1100G: [0°] _{20'} ; T800G: [0°] _{16'})	Strength: Ksi (MPa)	ASTM D6641	CTA	216	(1486)	223	(1539)
			RTA	226	(1558)	203	(1397)
			ETW 180°F	181	(1248)	171	(1177)
			ETA	204	(1407)	186	(1283)
Compression After Impact (RTA)	Strength: Ksi (MPa)	ASTM D7137	1500 in-lb/in	42.1	(290)	44.5	(307)
			1000 in-lb/in	47.9	(330)	51.7	(356)
±45° In-Plane Shear	Strength: Ksi (MPa)	ASTM D3518	CTA	22.2	(153)	24.6	(170)
			RTA	23.3	(161)	23.7	(163)
			ETW 180°F	17.4	(120)	16.9	(117)
			ETA	18.6	(128)	16.0	(110)
	Modulus: Msi (GPa)	ASTM D3518	CTA	0.85	(5.9)	0.90	(6.2)
			RTA	0.73	(5.0)	0.76	(5.2)
			ETW 180°F	0.54	(3.7)	0.54	(3.7)
			ETA	0.60	(4.1)	0.61	(4.2)

*Normalized to 60% Vf
RTA: Testing performed at 75°F (24°C), as-received moisture content
CTA: Testing performed at -65°F (-54°C), as-received moisture content
ETW: Testing performed at the stated temperature, conditioned by H2O soak at 160°F (71°C) for 2 weeks
ETA: Testing performed at 250°F (121°C), as-received moisture content

TEST TYPE		TEST METHOD	TEST CONDITION	T800G UD		T1100G UD	
Open Hole Tension*	Strength: Ksi (MPa)	ASTM D5766	CTA RTA ETA	66.4 70.7 77.8	(458) (488) (536)	77.6 84.8 90.6	(535) (584) (624)
Open Hole Compression*	Strength: Ksi (MPa)	ASTM D6484	RT ETW 180°F ETW 250°F ETW 300°F	45.0 40.4 36.5 37.1	(310) (278) (252) (256)	48.9 44.7 42.5 39.5	(337) (308) (293) (273)
QI Unnotched Tension*	Strength: Ksi (MPa)	ASTM D3039 ASTM D5766	CTA RTA ETA ETW 180°F	143 148 148 150	(987) (1020) (1019) (1034)	154 160 167 165	(1060) (1106) (1150) (1137)
	Modulus: Msi (GPa)		CTA RTA ETA ETW 180°F	8.8 8.5 8.1 8.5	(61) (59) (56) (58)	9.6 9.4 8.7 9.3	(66) (65) (60) (64)
QI Unnotched Compression*	Strength: Ksi (MPa)	ASTM D8066 ASTM D6484	RTA ETA ETW 180°F	103 78 81	(711) (539) (561)	111 85 87	(763) (584) (597)
	Modulus: Msi (GPa)		RTA ETA ETW180°F	7.8 9.9 7.3	(54) (68) (50)	8.2 9.2 8.6	(57) (63) (59)
0° Short Beam Shear*	Strength: Ksi (MPa)	ASTM D2344	RTA ETW 180°F ETW 250°F ETW 300°F ETW 350°F ETW 375°F	20.1 13.1 11.0 9.6 8.0 -	(139) (90) (76) (66) (55) -	19.5 12.7 10.6 8.2 7.4 6.6	(135) (88) (73) (56) (51) (46)
Double Shear Bearing Tension, Procedure A*	Strength: Ksi (Mpa)	ASTM D5961	RTA ETW 180°F	122 124	(845) (855)	127 127	(878) (876)

*Normalized to 60% Vf

RTA: Testing performed at 75°F (24°C), as-received moisture content

CTA: Testing performed at -65°F (-54°C), as-received moisture content

ETW: Testing performed at the stated temperature, conditioned by H2O soak at 160°F (71°C) for 2 weeks

ETA: Testing performed at 250°F (121°C), as-received moisture content



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