CYCOM® 950-1 Epoxy Prepreg

DESCRIPTION

CYCOM® 950-1 modified epoxy resin is a 121°C (250°F) cure system with the performance of a 177°C (350°F) curing epoxy. CYCOM 950-1 prepreg is curable under vacuum-bag-only pressure conditions.

CYCOM 950-1 is a controlled flow, net resin content material that offers significant advantages over wet lay-up systems for structural repairs. Advantages include favorable stress-strain characteristics, product quality and consistency, speed of lay-up and vastly improved health and safety characteristics.

FEATURES & BENEFITS

- Aerospace qualified
- Low outgassing. Approved for space flight
- Controlled flow material
- Improved toughness compared with first- and second-generation structural epoxies
- Dry service temperature of 150°C (300°F) when cured at 135°C (275°F)
- Mechanical properties of a 177°C (350°F) curing material when cured at 135°C (275°F)
- Mechanical properties to 104°C (220°F) hot/wet
- Oven/vacuum bag cure capability as well as autoclave positive pressure cure
- Efficient for structural repair
- Conventional drying, lay-up, vacuum bagging and localized low-level heating is all that is required for most applications
- Shop life of 8 weeks at ambient conditions
- Suitable for laminate and sandwich panel usage
- Co-curable with various aerospace qualified adhesive materials

SUGGESTED APPLICATIONS

- Helicopter fuselage and rotor components
- Wing structures
- Field repairs and permanent repairs
- Space flight applications

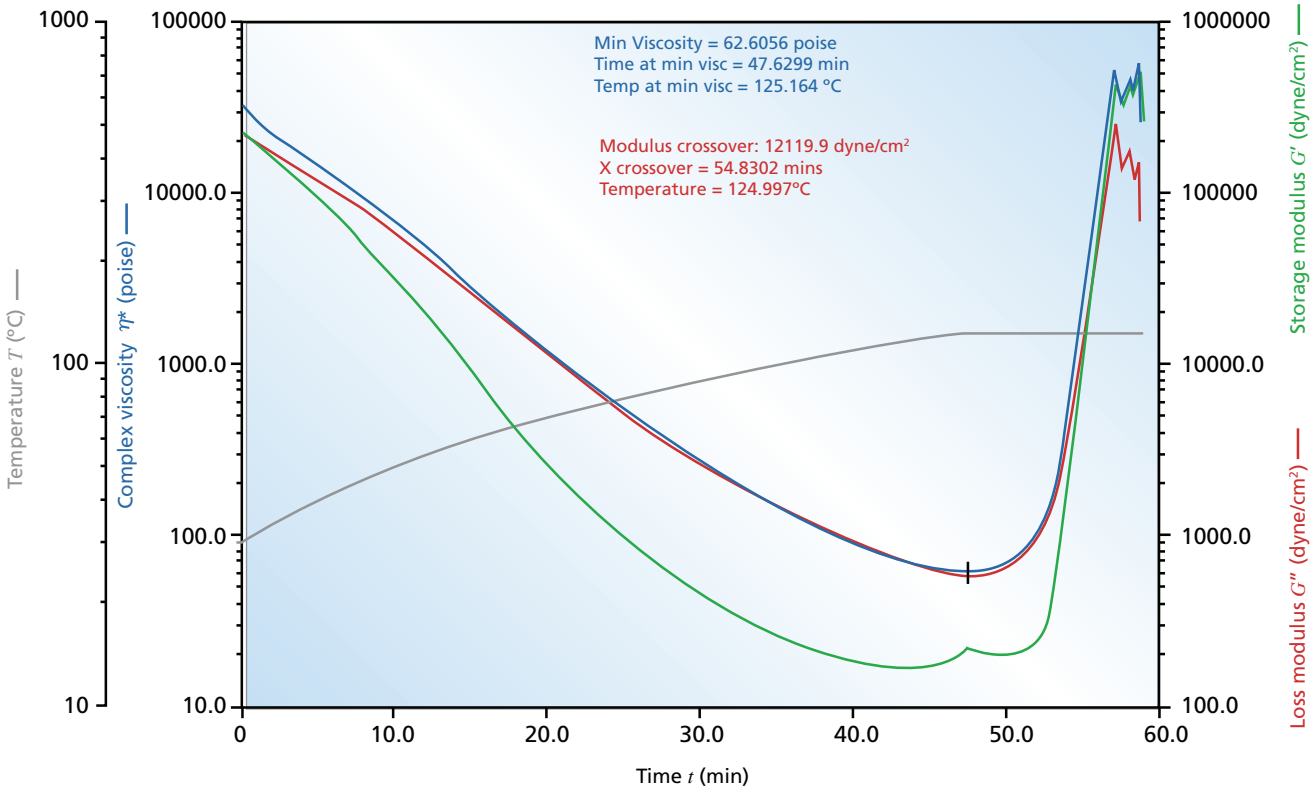
CHARACTERISTICS

Table 1 | Physical Characteristics

Shelf life	1 year when stored at less than-18°C (0°F)
Shop Life	Up to 8 weeks at room temperature
Gel Time	13 minutes at 135°C (275°F)
Cured Resin Density	1.27 g/cm³

Resin Viscosity

Figure 1 | Viscosity Trace of CYCOM 950-1
Ramp Rate of 2°C (4°F)/min to 121°C (250°F)

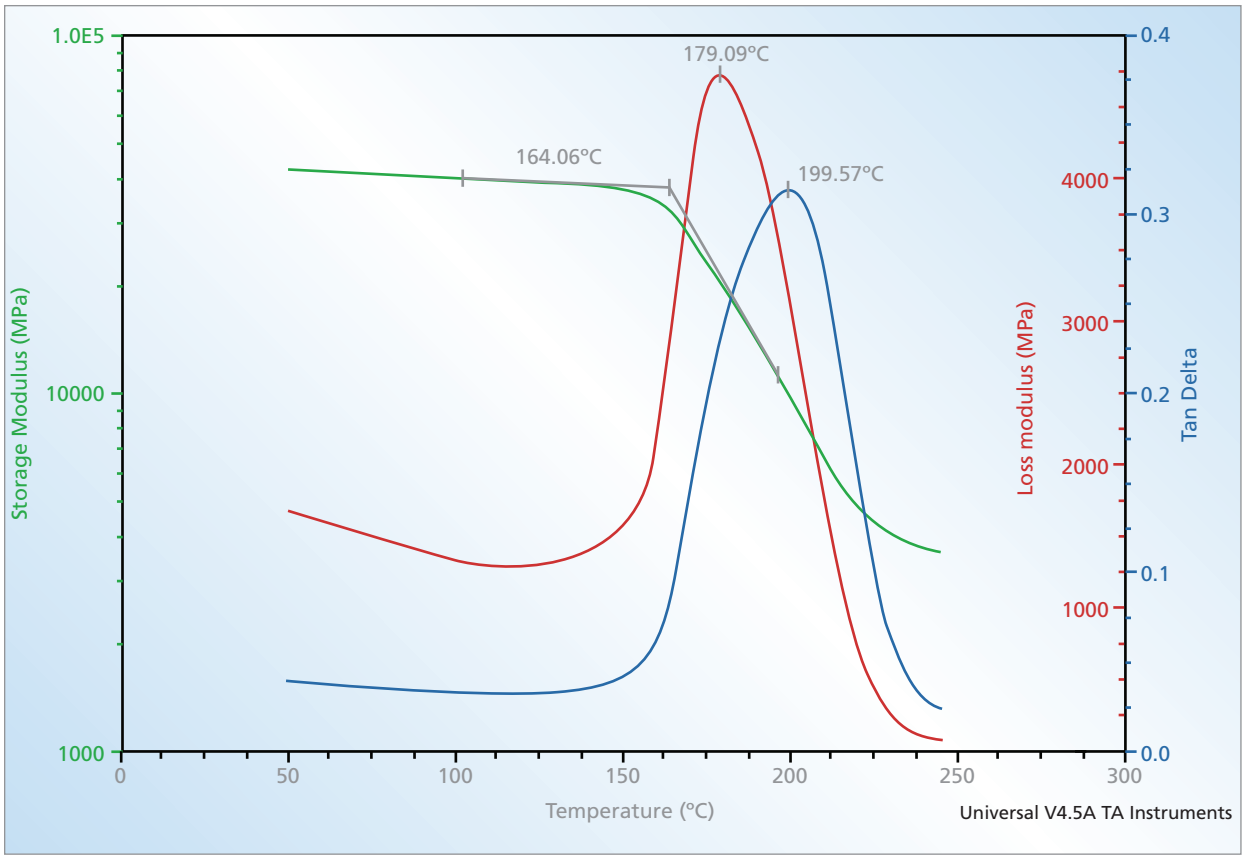


Glass Transition Temperature

NOTE: Tg data is not applicable for U.S. export control classification or licensing.

For export-related information please contact us.

Figure 2 | DMA Trace of CYCOM 950-1-33%- M55J UD Cured for 2 hours at 121°C (250°F)



PROPERTIES

Table 2 | Neat Resin Properties

Property	Test Value
Tensile Strength , MPa (ksi)	52.4 (7.6)
Tensile Modulus , GPa (msi)	4.0 (0.6)
Tensile Strain to failure , %	1.5
Outgassing TML , %	0.5 – 0.7
Outgassing RML , %	0.24
Outgassing CVCM , %	0.02 – 0.04

Table 3 | Mechanical Properties – Unidirectional Carbon Tape
Note: Test results normalized where applicable to fiber volume = 60%

Property	36%-HS-140 GSM		36%-M46J-140 GSM			36%-M55J-140 GSM
	23°C (73°F) Dry	80°C (176°F) Dry	23°C (73°F) Dry	80°C (176°F) Dry	132°C (270°F) Dry	23°C (73°F) Dry
0° Tensile						
Strength, MPa (ksi)	2190 (318)	1730 (251)	2022 (293)	1953 (283)	2062 (299)	1764 (256)
Modulus, GPa (msi)	135 (19.6)	137 (19.9)	254 (36.8)	252 (36.5)	284 (41.2)	307 (44.5)
90° Tensile						
Strength, MPa (ksi)	-	-	-	-	-	25 (3.6)
Modulus, GPa (msi)	-	-	-	-	-	5.9 (0.86)
0° Compression						
Strength, MPa (ksi)	1410 (204)	1125 (163)	925 (134)	-	889 (129)	899 (130)
Modulus, GPa (msi)	121 (17.5)	120 (17.4)	243 (35.2)	247 (35.8)	238 (34.5)	281 (40.7)
90° Compression						
Strength, MPa (ksi)	-	-	-	-	-	193 (28.0)
Modulus, GPa (msi)	-	-	-	-	-	6.4 (0.93)
0° Flexural						
Strength, MPa (ksi)	1583 (229)	1232 (179)	1487 (215)	1343 (195)	1183 (172)	1141 (165)
Modulus, GPa (msi)	120 (17.4)	115 (16.7)	225 (32.6)	231 (33.5)	-	220 (31.9)
Interlaminar Shear						
Strength, MPa (ksi)	92 (13.3)	74 (10.7)	80 (11.6)	71 (10.3)	63 (9.1)	68 (9.9)
In Plane Shear						
Strength, MPa (ksi)	-	-	-	-	-	84 (12.2)
Modulus, GPa (msi)	-	-	-	-	-	3.1 (0.45)

Table 4 | Mechanical Properties – Plain Weave Carbon Fabric
Note: Test results normalized where applicable to fiber volume = 55%

Property	42%-HS-Plain Weave–200 GSM		42%-T800-Plain Weave–200 GSM			42%-M46J-Plain Weave–280 GSM		
	23°C (73°F) Dry	80°C (176°F) Dry	23°C (73°F) Dry	80°C (176°F) Dry	132°C (270°F) Dry	23°C (73°F) Dry	80°C (176°F) Dry	132°C (270°F) Dry
0° Tensile								
Strength, MPa (ksi)	725 (105)	655 (95)	1099 (159)	996 (144)	982 (142)	689 (100)	691 (100)	849 (123)
Modulus, GPa (msi)	68 (9.9)	65 (9.4)	82 (11.9)	81 (11.7)	78 (11.3)	126 (18.3)	127 (18.4)	129 (18.7)
90° Tensile								
Strength, MPa (ksi)	710 (103)	-	-	-	-	-	-	-
Modulus, GPa (msi)	61 (8.8)	-	-	-	-	-	-	-
0° Compression								
Strength, MPa (ksi)	704 (102)	602 (87)	749 (109)	603 (87)	406 (59)	407 (59)	425 (62)	309 (45)
Modulus, GPa (msi)	56 (8.1)	56 (8.1)	77 (11.2)	71 (10.3)	68 (9.9)	111 (16.1)	111 (16.1)	109 (15.8)
90° Compression								
Strength, MPa (ksi)	725 (105)	-	-	-	-	-	-	-
Modulus, GPa (msi)	57 (8.3)	-	-	-	-	-	-	-
0° Flexural								
Strength, MPa (ksi)	-	-	1287 (187)	1083 (157)	523 (76)	658 (95)	559 (81)	400 (58)
Modulus, GPa (msi)	-	-	77 (11.2)	73 (10.6)	65 (9.4)	101 (14.6)	101 (14.6)	94 (13.6)
Interlaminar Shear								
Strength, MPa (ksi)	72 (10.4)	-	69 (10.0)	60 (8.7)	43 (6.2)	48 (7.0)	38 (5.5)	37 (5.4)
In Plane Shear								
Strength, MPa (ksi)	104 (15)	-	-	-	-	-	-	-
Modulus, GPa (msi)	4.5 (0.7)	-	-	-	-	-	-	-
Compression After Impact [(45/0/0)2 (45/0/45)]S								
Strength,MPa (ksi)	205 (30)	-	-	-	-	-	-	-
Open Hole Tensile $(45/0)_{3S}$								
Strength, MPa (ksi)	315 (46)	-	-	-	-	-	-	-
Open Hole Compression $(45/0)_{3S}$								
Strength, MPa (ksi)	266 (39)	-	-	-	-	-	-	-
Pin Bearing Double Shear $(45/0)_{3S}$								
Strength, MPa (ksi)	533 (77)	-	-	-	-	-	-	-

Table 5 | Mechanical Properties – 5 Harness Carbon Fabric
Note: Test results normalized where applicable to fiber volume = 55%

Property	42%-HS-5H–280 GSM		42%-T800-5H–280 GSM			42%-M46J-5H–280 GSM		
	23°C (73°F) Dry	80°C (176°F) Dry	23°C (73°F) Dry	80°C (176°F) Dry	132°C (270°F) Dry	23°C (73°F) Dry	80°C (176°F) Dry	132°C (270°F) Dry
0° Tensile								
Strength, MPa (ksi)	903 (131)	764 (111)	1149 (167)	1138 (165)	962 (139)	835 (121)	779 (113)	-
Modulus, GPa (msi)	73 (10.6)	69 (10.0)	84 (12.2)	85 (12.3)	82 (11.9)	132 (19.1)	127 (18.4)	-
90° Tensile								
Strength, MPa (ksi)	860 (125)	-	-	-	-	-	-	-
Modulus, GPa (msi)	64 (9.3)	-	-	-	-	-	-	-
0° Compression								
Strength, MPa (ksi)	862 (125)	690 (100)	698 (101)	650 (94)	378 (55)	508 (74)	485 (70)	330 (48)
Modulus, GPa (msi)	63 (9.1)	64 (9.3)	77 (11.2)	75 (10.9)	74 (10.7)	114 (16.5)	112 (16.2)	111 (16.1)
90° Compression								
Strength, MPa (ksi)	800 (116)	-	-	-	-	-	-	-
Modulus, GPa (msi)	65 (9.4)	-	-	-	-	-	-	-
0° Flexural								
Strength, MPa (ksi)	1077 (156)	852 (124)	1218 (177)	979 (142)	529 (77)	728 (106)	670 (97)	592 (86)
Modulus, GPa (msi)	62 (9.0)	64 (9.3)	77 (11.2)	75 (10.9)	76 (11.0)	107 (15.5)	111 (16.1)	97 (14.1)
Interlaminar Shear								
Strength, MPa (ksi)	73 (10.6)	61 (8.8)	77 (11.2)	65 (9.4)	48 (7.0)	49 (7.1)	50 (7.3)	44 (6.4)
In Plane Shear								
Strength, MPa (ksi)	98 (14.2)	-	-	-	-	-	-	-
Modulus, GPa (msi)	4.6 (0.67)	-	-	-	-	-	-	-

Table 6 | Mechanical Properties – CYCOM 950-1-52%- Kevlar Fabric

Property	Normalized	285 Kevlar *	120 Kevlar **
		23°C (73°F) Dry	23°C (73°F) Dry
0° Tensile			
Strength, MPa (ksi)	Yes	535 (77.6)	409 (59.3)
Modulus, GPa (msi)	Yes	32 (4.70)	24.1 (3.50)
90° Tensile			
Strength, MPa (ksi)	Yes	434 (62.9)	-
Modulus, GPa (msi)	Yes	28.2 (4.09)	-
0° Compression			
Strength, MPa (ksi)	Yes	205 (29.7)	182 (26.4)
Modulus, GPa (msi)	Yes	25.4 (3.69)	19.3 (2.80)
90° Compression			
Strength, MPa (ksi)	Yes	206 (29.8)	-
Modulus, GPa (msi)	Yes	25.2 (3.66)	-
0° Flexural			
Strength, MPa (ksi)	Yes	442 (64.1)	293 (3.28)
Modulus, GPa (msi)	Yes	23.2 (3.36)	13.2 (1.92)
Interlaminar Shear			
Strength, MPa (ksi)	-	30.5 (4.42)	-
In Plane Shear			
Strength, MPa (ksi)	-	87 (12.6)	-
Modulus, GPa (msi)	-	1.93 (0.28)	-

* Data has been normalized to a standard cured ply thickness of 0.254mm (0.01 inches) where applicable

** Data has been normalized to a standard cured ply thickness of 0.114mm (0.0045 inches) where applicable

Table 7 | Summary of CYCOM 950-1- 38%-G7781 Prepreg Test Data

Mechanical Property	Test Temperature, °C (°F)			
	-55 (-65)	24 (74)	93 (200)	121 (250)
0° Tensile *				
Strength, MPa (ksi)	549 (79.6)	462 (67.0)	344 (49.9)	320 (46.4)
Modulus, GPa (msi)	25.8 (3.74)	3.39	2.97	1.82
90° Tensile *				
Strength, MPa (ksi)	477 (69.1)	376 (54.5)	279 (40.5)	237 (34.4)
Modulus, GPa (msi)	22.6 (3.27)	20.6 (2.99)	16.6 (2.41)	14.6 (2.11)
0° Compression *				
Strength, MPa (ksi)	630 (91.4)	500 (72.5)	352 (51.0)	232 (33.6)
Modulus, GPa (msi)	-	-	-	-
90° Compression *				
Strength, MPa (ksi)	510 (73.9)	428 (62.1)	274 (39.7)	233 (33.8)
Modulus, GPa (msi)	-	-	-	-
In Plane Shear				
Strength, MPa (ksi)	266 (38.6)	191 (27.7)	117 (17)	96 (13.9)
Modulus, GPa (msi)	16.1 (2.34)	11.9 (1.67)	5.0 (0.73)	2.1 (0.3)
0° Flexural *				
Strength, MPa (ksi)	866 (125.5)	648 (94.0)	365 (52.9)	268 (38.8)
Modulus, GPa (msi)	20.8 (3.01)	22.3 (3.24)	19.9 (2.89)	16.2 (2.35)
Interlaminar Shear				
Strength, MPa (ksi)	66.9 (9.7)	67.6 (9.8)	30.3 (4.4)	20.7 (3.0)

* Data has been normalized to a standard cured ply thickness of 0.254mm (0.0100 inches)

SUGGESTED PREPARATION AND PROCESSING PARAMETERS

Autoclave Processing

Laminate Preparation

- Cut the prepreg for the laminate
- Lay up the laminate in the desired configuration on a tool or caul plate that has been treated with release agent or film taking care not to distort the material
- As each ply of material is positioned, work out any entrapped air using light pressure with a paddle or roller before removing the release paper or poly film from that ply

Room Temperature Debulk

Vacuum debulking should only be required to eliminate wrinkles and bridging of materials in highly contoured structures or when producing thick parts in excess of 3 mm (0.125 inches).

- Lay-up and debulk the laminate at appropriate intervals
- Cover the laminate with one layer of perforated release film cut 25.4 mm (1 inch) larger than laminate on all sides
- Cover with one ply of Style 7781 (or similar) glass fabric
- Bag and seal the lay-up
- Apply at least 25" Hg vacuum for 15 – 30 minutes; time will be dependent on layup

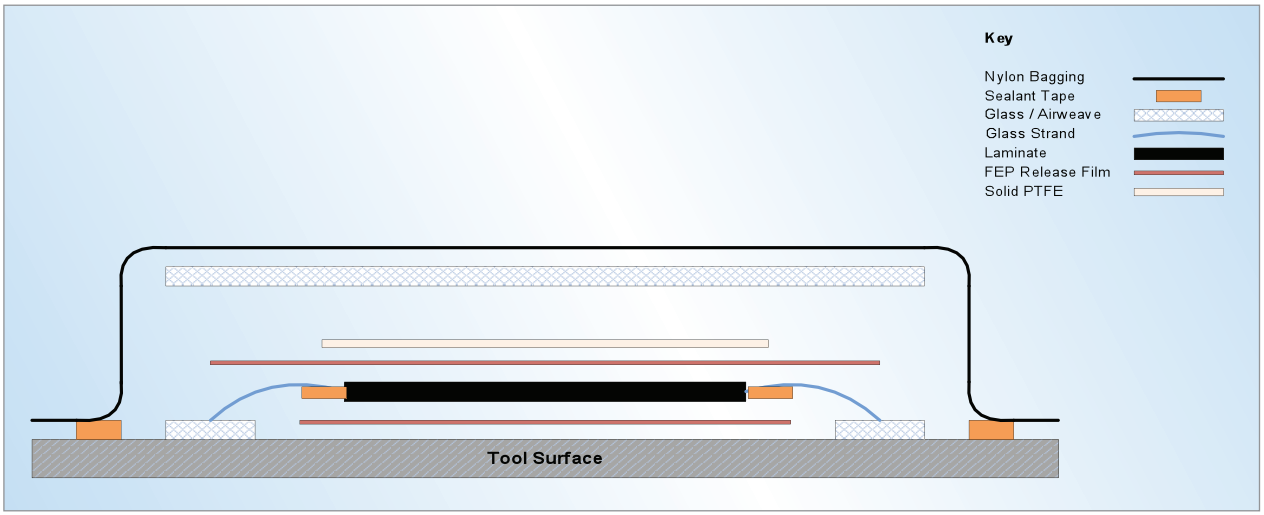
Final Bagging

- Do not move laminate from debulk position
- Use dams around lay-up as required. This is optional
- Suggested lay-up is shown in Figure 3. Alternative layups can be used. All layup methods should perform the following functions:
    - Prevent pinching off of the laminate edge
    - Allow air to easily be removed from the laminate perimeter
    - Prevent resin loss during cure
- The non-porous release film should be perforated on 100 – 150 mm (4 – 6 inch) centres to prevent air entrapment
- Any industry standard breather material can be used provided it effectively removes air and can withstand cure temperatures
- Bag and seal with nylon or equivalent fil

Leak Check

- A vacuum leak check should be performed prior to cure and heat-up. The test should not show more than a 2" Hg vacuum loss in 5 minutes

Figure 3 | Bagging Schematic

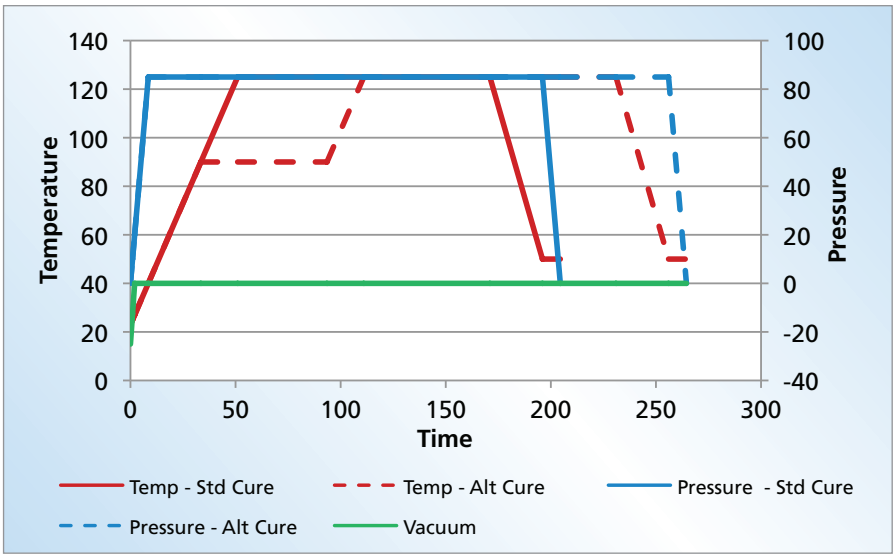


Cure Cycle

- Apply a minimum of 25" Hg vacuum from start of cure cycle
- Apply 85 ± 5 psi (0.59 ± 0.03 MPa) pressure; vent vacuum at 10 psi (0.07 MPa)
- Heat up at a rate of 1 – 2°C/minute (3 – 5°F/minute) to 90 ± 5°C (194 ± 10°F

  NOTE: If large or thick structures are being moulded, reduce heat up rate to 0.5 – 1°C/minute (1 – 3°F/minute) from start of cure cycle
- For laminates in excess of 3 mm (0.125 inches) thick, a 60 minute dwell is recommended at 90 ± 5°C (194 ± 10°F). Heat up from 90°C (210°F) at a rate of 0.5 – 1°C/minute (1 – 3°F/minute)
- Heat to 125°C (250°F) minimum; for optimum mechanical properties at a higher service temperature, it is recommended that the cure temperature should be 135 ± 5°C (275 ± 9°F). Do not exceed this temperature
- Hold at curing temperature for 2 hours
- Cool under pressure at 3°C/minute (approx. 6°F/minute) to below 50°C (122°F)

Figure 4 | Recommended Cure Cycle(s)



Vacuum Bag/Oven Processing

Final Bagging

- Use dams around lay-up as required. This is optional
- Apply one layer of porous PTFE-coated glass release cloth to the exposed surface of the lay-up or over the peel ply when a peel ply is present
- Apply one ply of Style 120 E Glass or equivalent bleeder cloth for every 8 plies of prepreg or as required
- When a caul plate is not used, the bleeder cloth should be isolated from the breather using non-porous release film. The bleeder should extend past the non-porous release film into contact with the breather. The non-porous release film should be perforated on 100 – 150 mm (4 – 6 inch) centres to prevent air entrapment
- Bag with nylon or equivalent film

Cure Cycle

- Maintain full vacuum on the bagged assembly
- Check the vacuum for pressure change and patch leaks that cause the bag to fall below 25" inches Hg
- Heat the assembly to 90 ± 5°C (194 ± 10°F) at no more than 2°C (5°F) per minute based on the highest temperature-indicating part thermocouple
- Dwell assembly at 90 ± 5°C (194 ± 10°F) for one hour
- Heat to 125°C (250°F) minimum; for optimum mechanical properties at a higher service temperature, it is recommended that the cure temperature should be 135 ± 5°C (275 ± 9°F). Do not exceed this temperature
- Hold for at least 120 minutes. The hold period begins when the lowest temperature indicating part thermocouple reaches 120°C (250°F)
- Cool to below 50°C (122°F) before releasing vacuum

PRODUCT HANDLING AND SAFETY

Cytec Engineered Materials recommends wearing clean, impervious gloves when working with epoxy resin systems to reduce skin contact and to avoid contamination of the product.

Materials Safety Data Sheets (MSDS) and product labels are available upon request and can be obtained from any Cytec Engineered Materials Office.

DISPOSAL OF SCRAP MATERIAL

Disposal of scrap material should be in accordance with local, state, and federal regulations.

CONTACT INFORMATION

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