CYCOM® 2040

CYCOM® 2040 is a very tough modified epoxy resin system with exceptional high temperature performance. It is suitable for highly stressed components exposed to elevated temperature environments (under bonnet/engine bay) including impact/crash structures. A two hour cure at 180°C (356°F) generates a Tg of over 200°C (392°F)* and offers excellent mechanical properties at both ambient and elevated temperatures.

CYCOM 2040 is available on woven and unidirectional carbon, glass and man-made fibres.

Features and Benefits

- Very tough resin system
- >200°C (392°F) glass transition temperature following 180°C (356°F) cure *
- Excellent mechanical properties
- High levels of mechanical property retention at elevated temperatures
- Controlled flow
- Excellent cured surface quality
- Low cured resin density (1.21g/cm³)
- Free-standing post curable to 200°C (356°F) for maximum temperature performance
- Shop life of 21 days at ambient [23°C (73°F)]
- Available in a wide range of fibres and fabric weaves

SUGGESTED APPLICATIONS

- Primary vehicle structures including chassis, engine frames suspension components and aerodynamic wings
- Impact structures including nose cone, side and rear
- Components requiring operating temperatures up to 200°C (392°F)

* Tg data is not applicable for U.S. export control classification or licensing. For export-related information please contact us.

CHARACTERISTICS

Table 1 | Physical Characteristics

Shelf Life	1 year when stored at less than -18°C (0°F)
Tack Life	Up to 21 days at 24°C (75°F)
Shop Life	Up to 21 days at 24°C (75°F)
Cured Resin Density	1.21 g/cm^3

Table 2 | Resin Viscosity Characteristics

Minimum Viscosity (poise)	160
Minimum Viscosity Temp, °C (°F)	150 (302)
Gel Temp, °C (°F)	167 (333)
Gel Time (minutes)	58

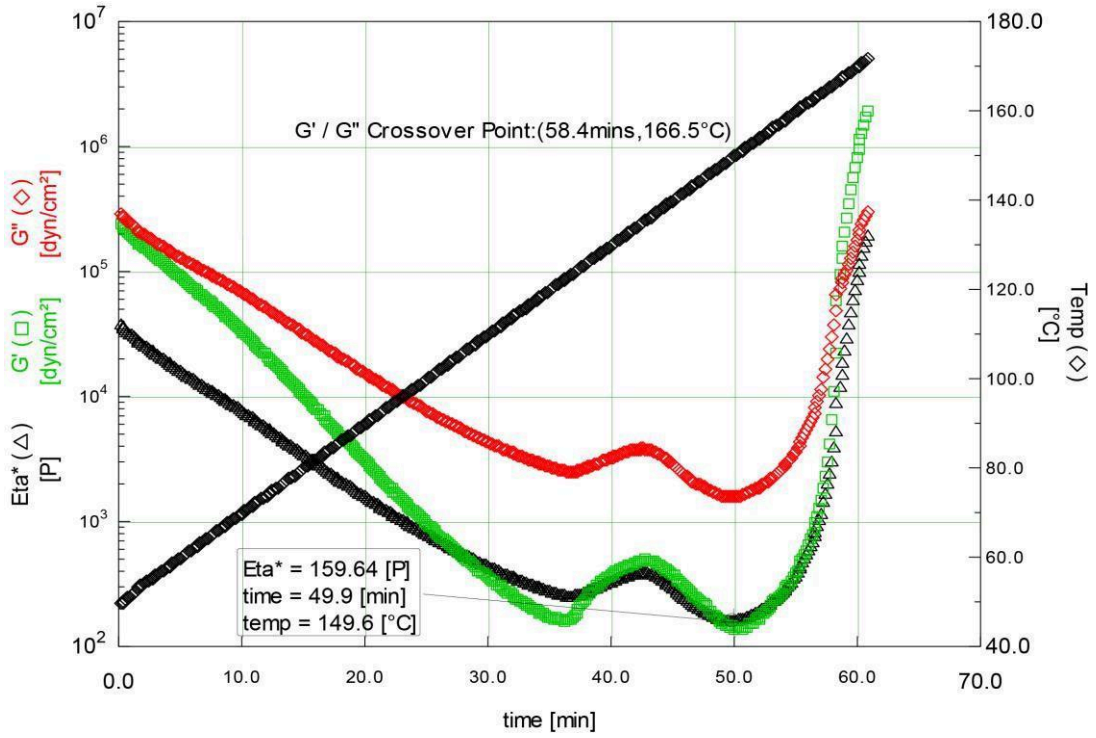

Figure 1 | Viscosity trace of CYCOM 2040
Ramp rate = 2°C/min. Minimum viscosity = 159.6 poise.

GLASS TRANSITION TEMPERATURE*

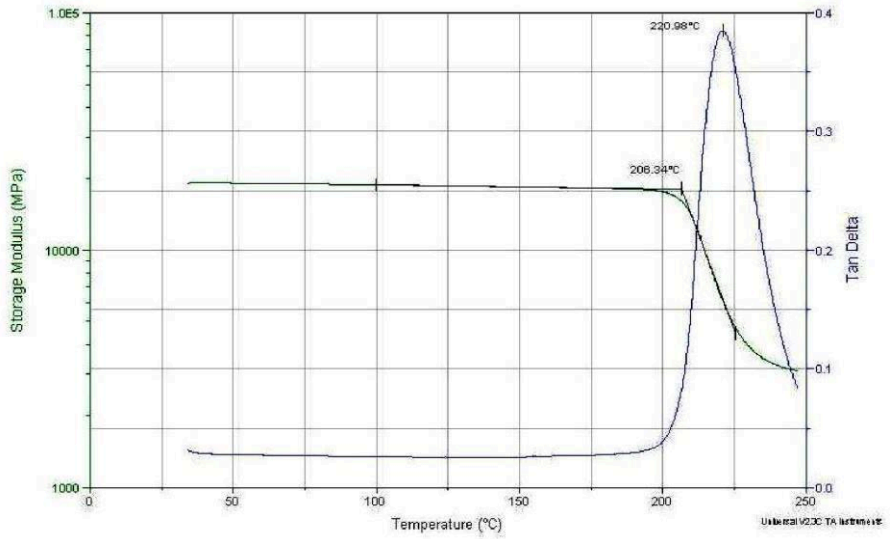

Figure 2 | Typical DMA trace for CYCOM 2040 following a 2hr @ 180°C cure

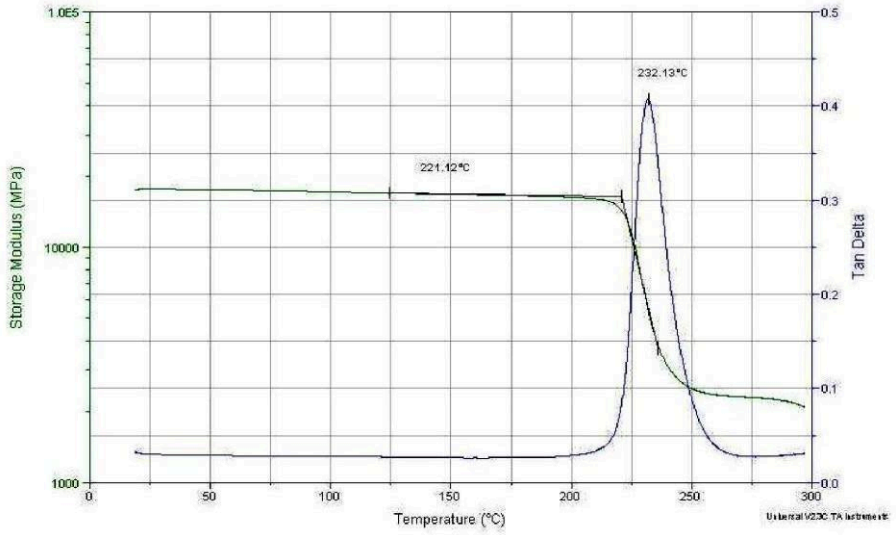

Figure 3 | Typical DMA trace for CYCOM 2040 following a 2hr @ 180°C cure and 2hr @ 200°C post cure

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PROPERTIES

Table 3 | Mechanical Properties of CYCOM 2040 Unidirectional Tape

Properties	2040-36%T800-140				2040-36%M55J-140			
	RT DRY Actual 53.2% VF	RT DRY Normalized 60% VF	150°C (302°F) Actual 53.2% VF	150°C (302°F) Normalized 60% VF	RT DRY Actual 52.4% VF	RT DRY Normalized 60% VF	150°C (302°F) Actual 52.4% VF	150°C (302°F) Normalized 60% VF
0° Tensile								
Strength, MPa (ksi)	2400 (348)	2570 (373)	2133 (309)	2406 (349)	1622 (235)	1853 (269)	1449 (210)	1656 (240)
Modulus, GPa (msi)	160 (23)	172 (25)	150 (22)	170 (25)	297 (43)	339 (49)	283 (41)	323
90° Tensile								
Strength, MPa (ksi)	51.4 (7.5)	-	45.8 (6.6)	-	35.1 (5.1)	-	26.9 (3.9)	-
Modulus, GPa (msi)	7.5 (1.09)	-	5.9 (0.86)	-	5.62 (0.81)	-	4.74 (0.69)	-
0° Compression								
Strength, MPa (ksi)	1304 (189)	1471 (213)	1073 (156)	1210 (176)	600 (87)	695 (101)	495 (72)	573 (83)
Modulus, GPa (msi)	133 (19)	150 (22)	143 (21)	161 (23)	263 (38)	305 (44)	246 (36)	285 (41)
90° Compression								
Strength, MPa (ksi)	271.2 (39)	-	123.3 (18)	-	190.6 (28)	-	93.9 (14)	-
Modulus, GPa (msi)	9.3 (1.35)	-	7.1 (1.03)	-	6.08 (0.88)	-	5.75 (0.83)	-
0° Flexural								
Strength, MPa (ksi)	1688 (244)	1904 (276)	1408 (204)	1588 (230)	972 (140)	1104 (160)	873 (127)	992 (144)
Modulus, GPa (msi)	141 (21)	159 (23)	160 (23)	181 (26)	233 (34)	265 (38)	251 (36)	285 (41)
90° Flexural								
Strength, MPa (ksi)	110.3 (16)	-	87.2 (13)	-	-	-	-	-
Modulus, GPa (msi)	7.0 (1.01)	-	6.8 (0.99)	-	-	-	-	-
Poisson's Ratio								
0°	0.32	-	0.41	-	-	-	-	-
90°	0.01	-	0.03	-	-	-	-	-
±45°	0.85	-	0.91	-	0.90	-	0.96	-
Interlaminar Shear								
Strength, MPa (ksi)	96.9 (14.1)	-	62.4 (9.0)	-	67.4 (9.8)	-	47.9 (6.9)	-
In Plane Shear								
Strength, MPa (ksi)	126.6 (18.4)	-	86.6 (12.6)	-	56.3 (8.2)	-	52.9 (7.7)	-
Modulus, GPa (msi)	3.3 (0.48)	-	2.38 (0.35)	-	4.60 (0.67)	-	2.72 (0.39)	-
Compression Strength After Impact (CSAI) MPa (ksi)	186.3 (27)	-	-	-	-	-	-	-
Bearing Strength								
Strength, MPa (ksi)	903.2 (131)	-	-	-	-	-	-	-
G_{Ic} J/m²	266.3	-	-	-	-	-	-	-

Cure Cycle: 2 hours at 180°C (356°F)

Table 4 | Mechanical Properties of CYCOM 2040 Fabric

Properties	2040-42%-6KT800-2X2T-200				2040-42%-6KM46J-2X2T-200			
	RT DRY Actual 46.8% VF	RT DRY Normalized 55% VF	150°C (302°F) Actual 46.8% VF	150°C (302°F) Normalized 55% VF	RT DRY Actual 47.3% VF	RT DRY Normalized 55% VF	150°C (302°F) Actual 47.3% VF	150°C (302°F) Normalized 55% VF
0° Tensile								
Strength, MPa (ksi)	874 (127)	1027 (149)	953 (138)	1120 (162)	597 (87)	694 (101)	761 (110)	885 (128)
Modulus, GPa (msi)	69.7 (10.1)	81.9 (11.9)	70.3 (10.2)	82.6 (12.0)	108.0 (15.7)	125.6 (18.2)	102.8 (14.9)	119.5 (17.3)
90° Tensile								
Strength, MPa (ksi)	855 (124)	1005 (146)	806 (117)	947 (137)	579 (84)	674 (98)	756 (109)	879 (127)
Modulus, GPa (msi)	69.6 (10.1)	81.8 (11.9)	69.1 (10.0)	81.2 (11.8)	102.0 (14.8)	118.6 (17.2)	104.5 (15.2)	121.5 (17.6)
0° Compression								
Strength, MPa (ksi)	671 (97)	789 (114)	528 (76)	621 (90)	419 (61)	487 (71)	433 (62)	504 (73)
Modulus, GPa (msi)	59.9 (8.7)	70.4 (10.2)	60.4 (8.8)	71.0 (10.3)	87.2 (12.6)	101.4 (14.7)	92.5 (13.4)	107.6 (15.6)
90° Compression								
Strength, MPa (ksi)	630 (91)	741 (107)	498 (72)	585 (85)	422 (61)	491 (71)	380 (55)	442 (64)
Modulus, GPa (msi)	59.6 (8.6)	70.0 (10.2)	60.5 (8.8)	71.1 (10.3)	85.7 (12.4)	99.7 (14.5)	90.1 (13.1)	104.8 (15.2)
0° Flexural								
Strength, MPa (ksi)	1049 (152)	1232 (179)	800 (116)	940 (136)	687 (100)	799 (115)	647 (94)	752 (109)
Modulus, GPa (msi)	67.9 (9.8)	79.8 (11.6)	71.4 (10.4)	83.9 (12.2)	92.4 (13.4)	107.4 (15.6)	95.4 (13.8)	110.9 (16.1)
90° Flexural								
Strength, MPa (ksi)	1096 (158)	1288 (186)	818 (118)	961 (139)	663 (96)	771 (112)	642 (93)	747 (108)
Modulus, GPa (msi)	68.6 (9.9)	80.6 (11.7)	73.5 (10.7)	86.4 (12.5)	95.1 (13.8)	110.6 (16.0)	92.7 (13.4)	107.8 (15.6)
Poisson's Ratio								
0°	0.03	-	0.07	-	0.02	-	-	-
90°	0.06	-	0.08	-	0.02	-	-	-
±45°	0.86	-	0.81	-	0.88	-	-	-
Interlaminar Shear								
Strength, MPa (ksi)	74.1 (10.7)	-	49.5 (7.2)	-	58.4 (8.5)	-	38.8 (5.6)	-
In Plane Shear								
Strength, MPa (ksi)	118.5 (17.2)	-	82.8 (12.0)	-	83.7 (12.1)	-	-	-
Modulus, GPa (msi)	3.58 (0.52)	-	2.49 (0.36)	-	3.1 (0.45)	-	-	-
Compression Strength After Impact (CSAI) MPa (ksi)	240.9 (35)	-	-	-	170.3 (25)	-	-	-
Bearing Strength								
Strength, MPa (ksi)	795.8 (115)	-	-	-	580.1 (84)	-	-	-
G_{Ic} J/m²	923.2	-	-	-	575.0	-	-	-

Cure Cycle: 2 hours at 180°C (356°F)

SUGGESTED PREPARATION AND PROCESSING PARAMETERS

Laminate Preparation

- Cut the prepreg for the laminate
- Lay up the laminate in the desired configuration onto the 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
- Apply vacuum bag using standard release films, breathers and bagging materials
- Insert at least two vacuum stems through the bag, connecting one to the vacuum source and the other, at a point on the part furthest from the source, to a calibrated vacuum gage

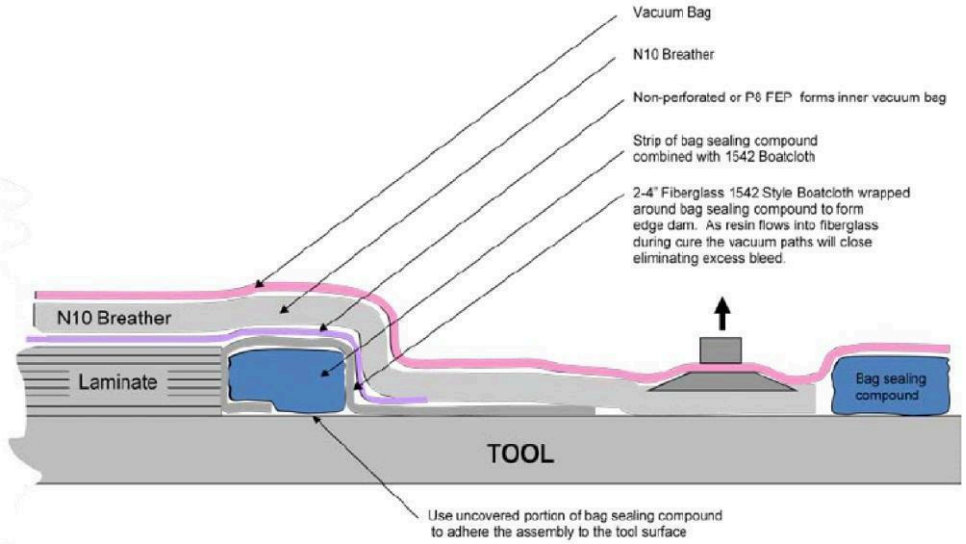

Figure 4 | Bagging Schematic

BAGGING MATERIAL NOTES

- Any industry standard breather material can be used provided it effectively removes air and can withstand cure temperatures.
- Use non-perforated FEP
- 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

DEBULKING

Vacuum debulking cycles are not required to eliminate voids for flat or mildly contoured parts. Vacuum debulking should be performed only as necessary to eliminate wrinkles and bridging of materials in highly contoured or very thick parts.

VACUUM REQUIREMENTS

Prior to cure, a vacuum hold of 4 hours at full vacuum (minimum 28 in Hg at sea level) is required. Full vacuum should be within 2 in Hg of absolute vacuum for the given altitude.

LEAK CHECK

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

CURE CYCLE

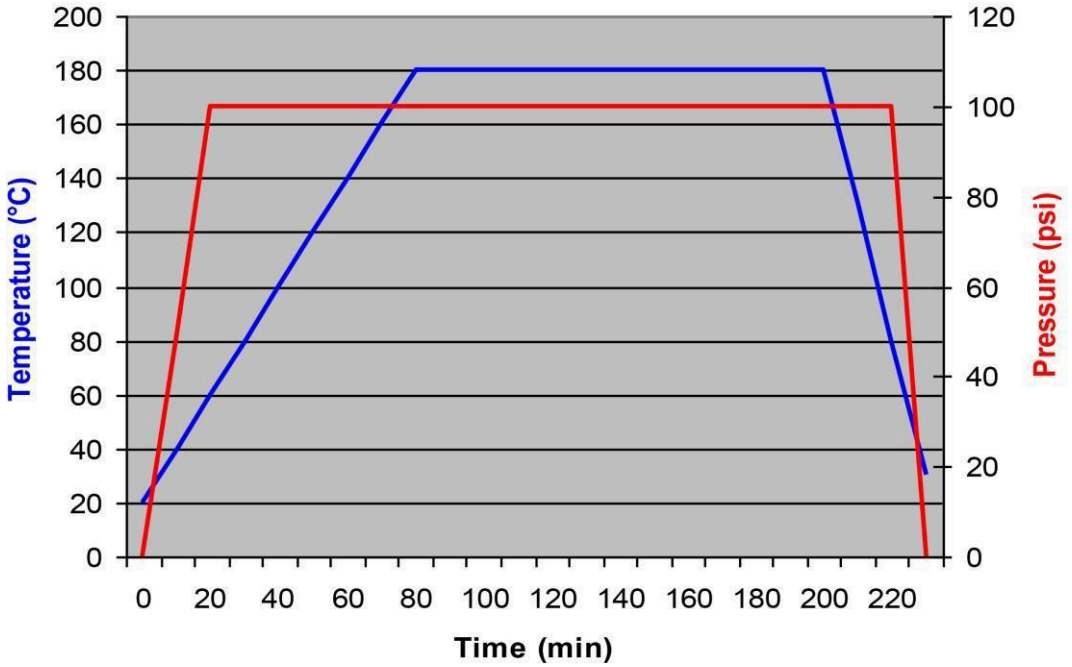

Figure 5 | Recommended Cure Cycle

- Apply full vacuum from start
- Apply 100 psi (689 kPa) pressure
- Heat up at a rate of 2°C/minute (4°F/minute) to 180°C (356°F)
- Hold at 180°C (356°F) for 120 minutes
- Cool autoclave to below 60°C (140°F) at 3°C/minute (6°F/minute)

POST CURE CYCLE

The recommended post cure cycle for CYCOM 2040 is as follows:

- Ramp temperature at 2°C/minute (4°F/minute) to 200°C (392°F)
- Hold at 200°C (392°F) for 120 minutes
- Cool oven to below 60°C (140°F) at 3°C/minute (6°F/minute)

ALTERNATE CURES

CYCOM 2040 can be cured at 135°C (275°F). An evaluation of various cure cycles has been completed, with Tg values provided below.

Table 5 | Cure Cycle Comparison

Cure Cycle	Tg (Modulus Onset)*	RT ILSS (T800 UD)	G_{IC} (T800 UD)	Approx % Cure
3hrs @ 135°C (275°F)	159	106	313	70
3hrs @ 135°C (275°F) + 2hrs @ 180°C (356°F) P/C	208	105	No Data	91
2hrs @ 180°C (356°F)	206	105	303	90
2hrs @ 180°C (356°F) + 2hrs @ 200°C (392°F) P/C	221	101	292	98

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HEALTH & SAFETY

Please refer to the product SDS for safe handling, personal protective equipment recommendations and disposal considerations.