

CYCOM® 5320-1

CYCOM® 5320-1 is a toughened epoxy resin prepreg system designed for vacuum-bag-only (VBO) or out of autoclave (OOA) manufacturing of primary structural parts. Because of its lower temperature curing capability, it is also suitable for prototyping where low cost tooling or VBO curing is required.

CYCOM 5320-1 handles like standard prepreg, yet can be vacuum bag cured to produce autoclave quality parts having very low porosity. It offers mechanical properties equivalent to other 350°F (177°C) autoclave-cured toughened epoxy prepreg systems after a 350°F (177°C) post-cure. The laminate can support a freestanding post-cure after an initial low temperature cure. The material can also be cured under positive pressure in an autoclave or press.

Features and Benefits

- Flexible cure cycles including vacuum bag only, autoclave and press molding
- Very low void content for vacuum bag only cure
- No autoclave required for cure, but autoclave cure options include low pressure autoclave cure and autoclave cure cycles compatible with other CYCOM and adhesive products
- Excellent hot/wet and notched properties
- Mechanical properties equivalent to those of autoclave-cured toughened epoxy systems
- Long tack and shop life at room temperature
- Available in woven fabric and unidirectional tape formats including materials for AFP and ATL
- Optimized processing characteristics for both monolithic laminate and honeycomb sandwich parts
- Suitable for producing complex parts
- Low temperature cure capability enables the use of low cost tooling

SUGGESTED APPLICATIONS

- Primary and secondary structure aerospace applications
- Prototype structural part applications

CHARACTERISTICS

Table 1 | Resin Characteristics

Properties	Description
Shelf Life	1 year at < 10°F (-12°C)
Tack Life	20 days at room temperature
Shop Life	30+ days minimum at room temperature
Cured Resin Density, g/cc	1.31
Wet Glass Transition Temperature, °F (°C) ^{1*}	324 (163)
Average Moisture Uptake, wt % ²	0.55

¹Exposure: 24-hour water boil; Test Method: DMA, E' onset

²Exposure: 48-hour water boil; Dry at 250°F (121°C) for 24 hours.

* NOTE: Tg data are not applicable for U.S. export control classification or licensing. For export-related information please contact Syensqo.



MECHANICAL PROPERTY DATA

CYCOM 5320-1 prepregs are supported by an extensive set of multi-batch mechanical and physical property databases. Product forms with supporting databases include:

- CYCOM® 5320-1 IM7 12K 145gsm 33% RW unidirectional tape – data available from Syensqo on request
- CYCOM® 5320-1 T650-35 3K 8HS Fabric 36% RW – data available from Syensqo on request
- CYCOM® 5320-1 IM7 PW Fabric 36% RW – data available from Syensqo on request
- CYCOM® 5320-1 T650-35 3K PW Fabric 36% RW – data available from NCAMP
- CYCOM® 5320-1 T650-35 12K 145gsm 33% RW unidirectional tape – data available from NCAMP



Table 2 | Lamina Level properties – Unidirectional Tape

Material: CYCOM® 5320-1 IM7 12K 145gsm 33%				Syensqo – CYCOM 5320-1/IM7 12K 145/33 Unidirectional Tape Lamina Mechanical Properties Summary		
Prepreg: CYCOM® 5320-1/IM7 145/33						
Fiber: Hexcel IM7 12K		Resin: CYCOM® 5320-1				
Tg (dry): 386°F	Tg (wet¹): 321°F		Tg Method: DMA (ASTM D7028, 35mm dual cantilever)			
Processing: full vacuum, vacuum bag only room temperature for 16 hours plus integrated 200°F/350°F cure/post cure cycle with a 200°F cure for 10 hours followed immediately under the same vacuum bag by a post cure at 350°F for two hours.						
Data reported as normalized (except where noted by parenthesis) by 0.0054 in. (59.9% nominal fiber volume)						
Condition	-100°F Dry	75°F Dry	250°F Dry	300°F Dry	180°F Wet¹	250°F Wet¹
Property	Mean	Mean	Mean	Mean	Mean	Mean
0° Tensile ASTM D3039						
Strength (ksi) ²	352.2	363.3	359.3		385.7	377.5
Modulus (Msi)	22.7	22.8	23.0		23.1	23.1
Poisson's Ratio	0.31	0.30	0.32		0.35	0.38
90° Tensile ASTM D3039						
Strength (ksi)	11.39	11.02	9.46		3.30	2.23
Modulus (Msi)	1.75	1.36	1.21		1.23	1.08
0° Compression ASTM D6641						
Strength (ksi) ²	314.9	301.4	292.4		239.1	190.3
Modulus (Msi)	20.87	20.82	20.96		20.90	21.15
0°/90° Tensile ASTM D3039						
Strength (ksi)	189.7	192.5	189.1	185.8	203.1	197.6
Modulus (Msi)	12.30	12.08	12.24	12.07	12.38	12.18
0°/90° Compression ASTM D6641						
Strength (ksi)	169.6	159.7	153.9	127.6	125.9	99.6
±45° Tensile In-Plane Shear (500–3,000 µstrain chord) ASTM D3518						
0.2% Offset Strength (ksi)	(11.76)	(8.08)	(5.73)	(5.00)	(5.01)	(3.44)
Shear Modulus (Msi)	(0.98)	(0.80)	(0.72)	(0.70)	(0.67)	(0.53)
0° Short Beam ASTM D2344						
Strength (ksi) ³		(19.4)				(8.8)

¹ Wet conditioning to equilibrium at 85%RW and 160°F

² Derived from 0°/90° strength results

³ 250°F 2 hr. + 350°F 2 hr. cure


Table 3 | Laminate Level properties – IM7 unidirectional tape

Material: CYCOM® 5320-1 IM7 12K 145gsm 33%						Syensqo – CYCOM 5320-1/IM7 12K 145/33 Unidirectional Tape Laminate Mechanical Properties Summary	
Prepreg: CYCOM® 5320-1/IM7 145/33							
Fiber: Hexcel IM7 12K			Resin: CYCOM® 5320-1				
Tg (dry): 386°F	Tg (wet¹): 321°F		Tg Method: DMA (ASTM D7028, 35mm dual cantilever)				
Processing: full vacuum, vacuum bag only room temperature for 16 hours plus integrated 200°F/350°F cure/post cure cycle with a 200°F cure for 10 hours followed immediately under the same vacuum bag by a post cure at 350°F for two hours.							
Data reported as normalized (except where noted by parenthesis) by 0.0054 in. (59.9% nominal fiber volume)							
Condition	-100°F Ambient	75°F Ambient	250°F Dry	300°F Dry	180°F Wet¹	220°F Wet¹	250°F Wet¹
Property	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Unnotched Tensile “Quasi” 25/50/25 ASTM D3039							
Strength (ksi)	123.5	133.0		131.5	131.1		129.5
Modulus (Msi)	8.85	8.58		8.40	8.46		8.36
Unnotched Compression “Quasi” 25/50/25 ASTM D6641							
Strength (ksi)	132.9	120.7		94.3	88.2		67.7
Modulus (Msi)	8.06	7.90		7.86	8.07		7.75
Interlaminar Tension (Angle Bend) “Quasi” 25/50/25 ASTM D6415							
Strength (ksi)	(10.37)	(9.83)		(8.42)			(3.90)
Open Hole Tension “Quasi” 25/50/25 ASTM D5766							
Strength (ksi)	72.6	75.7		75.3	76.7		73.9
Open Hole Compression “Quasi” 25/50/25 ASTM D6484							
Strength (ks)	56.1	53.7		47.0	43.6	39.9	38.6

¹ Wet conditioning to equilibrium at 85%RW and 160°F


Table 4 | Lamina Level Properties – T650-35 8 Harness Satin Fabric

Material: CYCOM® 5320-1 T650-35 3K 8HS Fabric 36%				Syensqo – CYCOM 5320-1/8HS T650/35 3k 8-Harness Satin Fabric Lamina Mechanical Properties Summary		
Prepreg: CYCOM® 5320-1 T650-35 3K 8HS 36%						
Fiber: Syensqo T650/35 3k		Resin: CYCOM® 5320-1				
Tg (dry): 374°F	Tg (wet¹): 316°F		Tg Method: DMA (ASTM D7028, 35mm dual cantilever)			
Processing: full vacuum, vacuum bag only room temperature for 16 hours plus integrated 200°F/350°F cure/post cure cycle with a 200°F cure for 10 hours followed immediately under the same vacuum bag by a post cure at 350°F for two hours.						
Data reported as normalized (except where noted by parenthesis) by 0.0145 in. (56.7% nominal fiber volume)						
Condition	-100°F Dry	75°F Dry	250°F Dry	300°F Dry	180°F Wet¹	250°F Wet¹
Property	Mean	Mean	Mean	Mean	Mean	Mean
0° Tensile ASTM D3039						
Strength (ksi)	117.4	131.3	128.8		138.0	136.4
Modulus (Msi)	10.20	10.02	10.06		10.20	9.97
Poisson's Ratio	0.056	0.048	0.042		0.041	0.041
90° Tensile ASTM D3039						
Strength (ksi)	119.3	129.9	133.8	137.0	138.4	134.2
Modulus (Msi)	10.14	9.90	10.00	10.00	10.02	9.94
0° Compression ASTM D6641						
Strength (ksi)	121.1	108.8	93.9		77.6	66.0
Modulus (Msi)	10.01	9.18	9.24		9.23	9.18
90° Compression ASTM D6641						
Strength (ksi)	122.3	110.6	95.4	87.8	87.9	66.7
Modulus (Msi)	9.42	9.18	9.20	9.30	9.36	9.15
±45° Tensile In-Plane Shear (500-3,000 µstrain chord) ASTM D3518						
0.2% Offset Strength (ksi)	(12.13)	(8.29)	(5.67)	(4.72)	(5.23)	(3.31)
Shear Modulus (Msi)	(0.95)	(0.81)	(0.72)	(0.67)	(0.71)	(0.53)
0° Short Beam ASTM D2344						
Strength (ksi)	(12.39)	(11.93)	(9.68)	(8.51)	(8.66)	(6.45)

¹ Wet conditioning to equilibrium at 85%RW and 160°F


TABLE 5 | Laminate level properties – 8 Harness Satin T650-35 Fabric

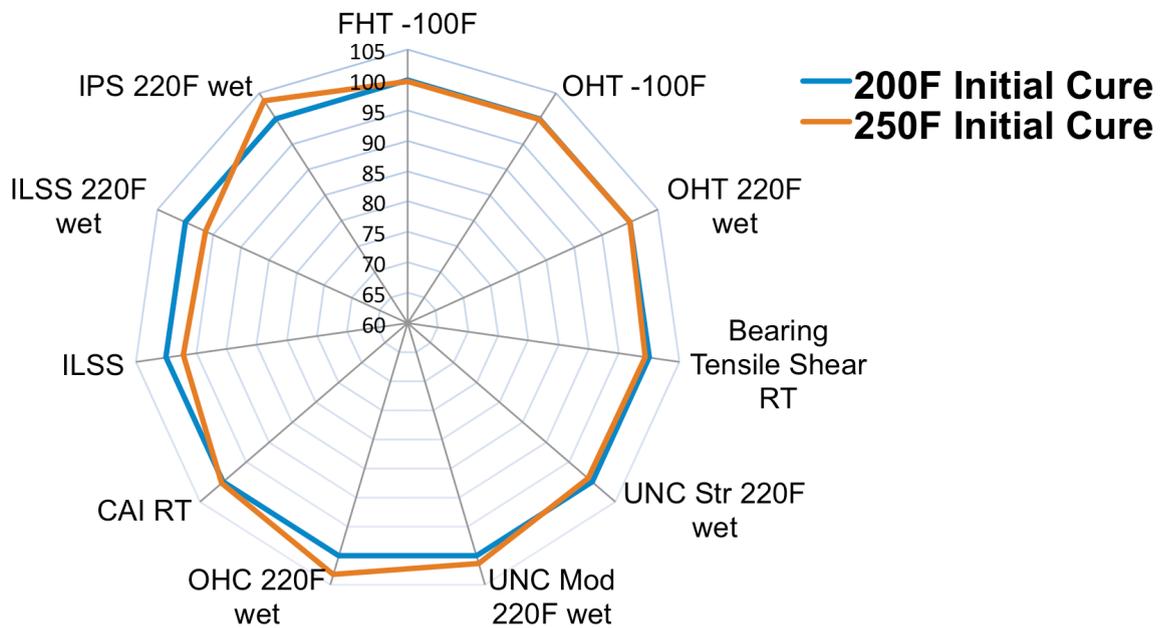
Material: CYCOM® 5320-1 T650-35 3K 8HS Fabric 36%				Syensqo – CYCOM 5320-1/8HS T650/35 3k 8-Harness Satin Fabric Laminate Mechanical Properties Summary		
Prepreg: CYCOM® 5320-1 T650-35 3K 8HS 36%						
Fiber: Syensqo T650/35 3k		Resin: CYCOM® 5320-1				
Tg (dry): 374°F	Tg (wet)¹: 316°F		Tg Method: DMA (ASTM D7028, 35mm dual cantilever)			
Processing: full vacuum, vacuum bag only room temperature for 16 hours plus integrated 200°F/350°F cure/post cure cycle with a 200°F cure for 10 hours followed immediately under the same vacuum bag by a post cure at 350°F for two hours.						
Data reported as normalized (except where noted by parenthesis) by 0.0145 in. (56.7% nominal fiber volume)						
	-100°F Ambient	75°F Ambient	250°F Dry	300°F Dry	180°F Wet¹	250°F Wet¹
Property	Mean	Mean	Mean	Mean	Mean	Mean
Unnotched Tensile “Quasi” 25/50/25 ASTM D3039						
Strength (ksi)	90.3	96.0	97.5	99.7	89.6	89.1
Modulus (Msi)	7.38	7.12	7.09	7.02	7.04	6.80
Unnotched Compression “Quasi” 25/50/25 ASTM D6641						
Strength (ksi)	114.2	97.5	77.6	70.3	71.3	60.3
Modulus (Msi)	6.88	6.68	6.69	6.48	6.50	6.42
Interlaminar Tension (Angle Bend) “Quasi” 25/50/25 ASTM D6415						
Strength (ksi)	(9.61)	(8.40)	(7.14)	(6.68)		(4.04)
Open Hole Tension “Quasi” 25/50/25 ASTM D5766						
Strength (ksi)	47.0	49.8	54.0	53.6	52.6	54.1
Open Hole Compression “Quasi” 25/50/25 ASTM D6484						
Strength (ks)	55.4	50.7	44.0	40.3	40.4	35.0

¹ Wet conditioning to equilibrium at 85%RW and 160°F


TABLE 6 | Compression After Impact Properties – T40-800B Unidirectional Tape, 145gsm 33%RW
250°F CURE; 350°F Postcure

Properties	Test Method Lay Up	Condition	Results
Compression After Impact Residual Strength, ksi (MPa))	ASTM D7137 or SACMA SRM02R94	RTA	25.6 (176)

CURE CYCLE FLEXIBILITY – T40-800B Unidirectional Tape, 145gsm, 33%RW, Low Temperature Initial Cures
Followed by 350°F Postcure



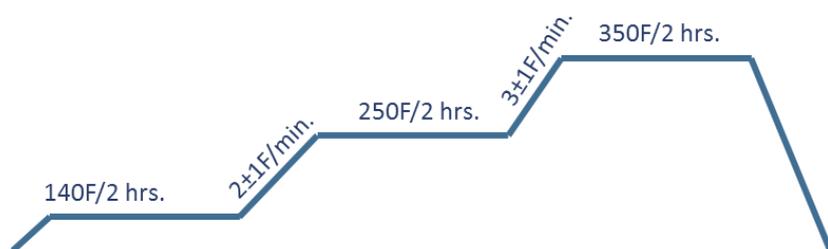
SUGGESTED PROCESSING PARAMETERS

CURE CYCLES

CYCOM® 5320-1 offers flexible cure cycle capability. Typical Vacuum Bag Only (VBO) Cure cycles:

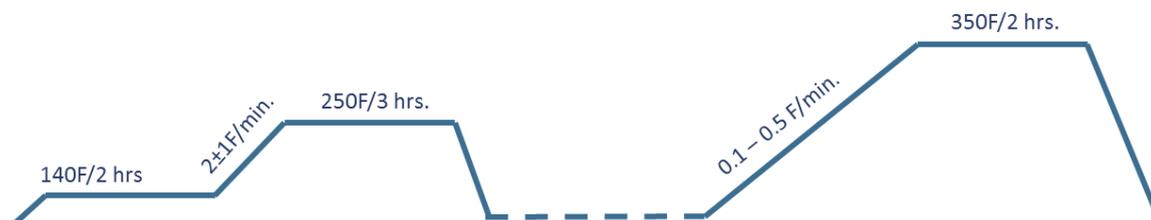
Cure Cycle A: Serial Production VBO Cure Cycle:

Heat to $140 \pm 5^\circ \text{F}$ for 120 ± 10 minutes; Ramp at $2 \pm 1^\circ \text{F}$ per minute to $250 \pm 10^\circ \text{F}$; Hold at $250 \pm 10^\circ \text{F}$ for 120 ± 10 minutes; Ramp at $3 \pm 1^\circ \text{F}$ per minute to $350 \pm 10^\circ \text{F}$; Hold at $350 \pm 10^\circ \text{F}$ for 120 ± 10 minutes; Cool at $< 10^\circ \text{F}$ to below 140°F .



Cure Cycle B: Low Temperature 250°F Initial VBO Cure; Free Standing Post-Cure to 350°F :

Heat to $140 \pm 5^\circ \text{F}$ for 120 ± 10 minutes; Ramp at $2 \pm 1^\circ \text{F}$ per minute to $250 \pm 10^\circ \text{F}$; Hold at $250 \pm 10^\circ \text{F}$ for 180 ± 10 minutes; Cool at $< 10^\circ \text{F}$ to below 140°F . Ramp at 0.1 to 0.5°F per minute to $350 \pm 10^\circ \text{F}$; Hold at $350 \pm 10^\circ \text{F}$ for 120 ± 10 minutes; Cool at $< 10^\circ \text{F}$ to below 140°F .



Cure Cycle C: 200°F Low Temperature VBO Initial Cure; Free Standing Post-Cure to 350°F

Heat to $140 \pm 5^\circ \text{F}$ for 120 ± 10 minutes; Ramp at $2 \pm 1^\circ \text{F}$ per minute to $200 \pm 10^\circ \text{F}$; Hold at $250 \pm 10^\circ \text{F}$ for 10 hours \pm 10 minutes; Cool at $< 10^\circ \text{F}$ to below 140°F . Ramp at 0.1 to 0.5°F per minute to $350 \pm 10^\circ \text{F}$; Hold at $350 \pm 10^\circ \text{F}$ for 120 ± 10 minutes; Cool at $< 10^\circ \text{F}$ to below 140°F .

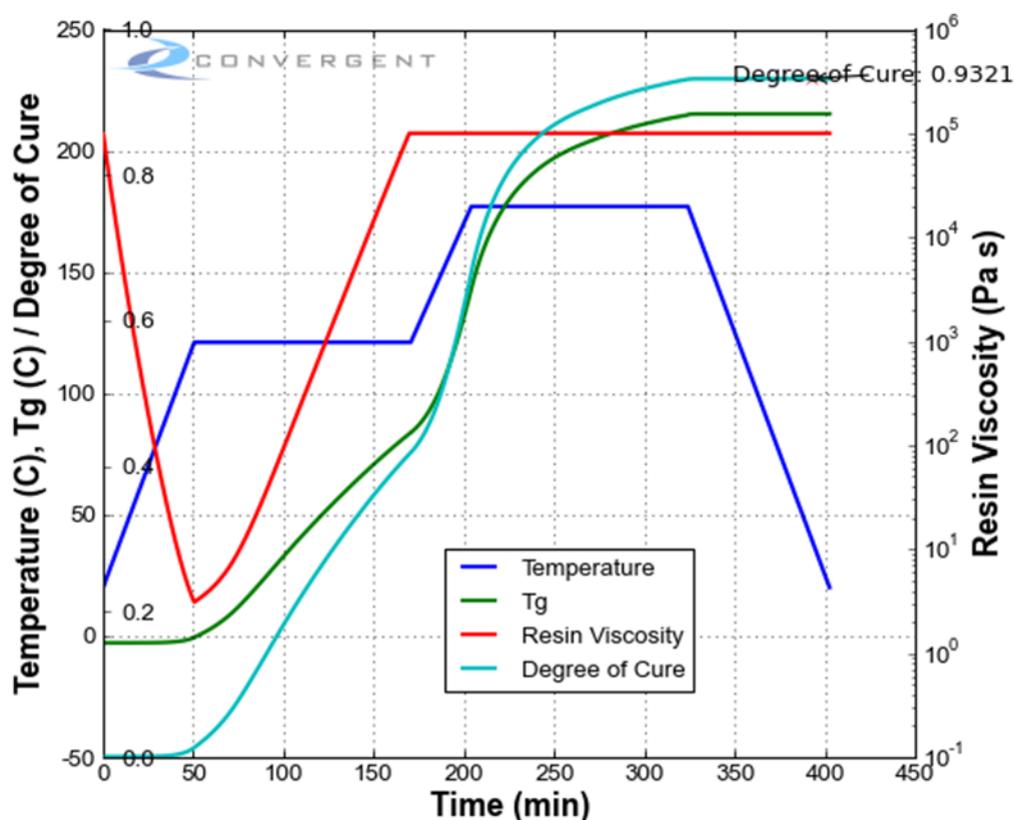


AUTOCLAVE OR POSITIVE PRESSURE CURES

CYCOM 5320-1 may be cured under positive pressure in an autoclave or via a bladder or press process. Please contact Syensqo for specific processing recommendations.

KINETIC MODEL

The RAVEN Simulation Software by Convergent Manufacturing Technologies, Inc. has characterized several Syensqo VBO resin and compatible adhesive systems in their kinetic modeling software. CYCOM 5320-1 VBO resin systems have been characterized in the RAVEN software and are included in a site license for the software.



Kinetic Model Output Example For CYCOM 5320-1 (RAVEN® Simulation Software by Convergent Manufacturing Technologies, Inc.)

DEBULKING

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



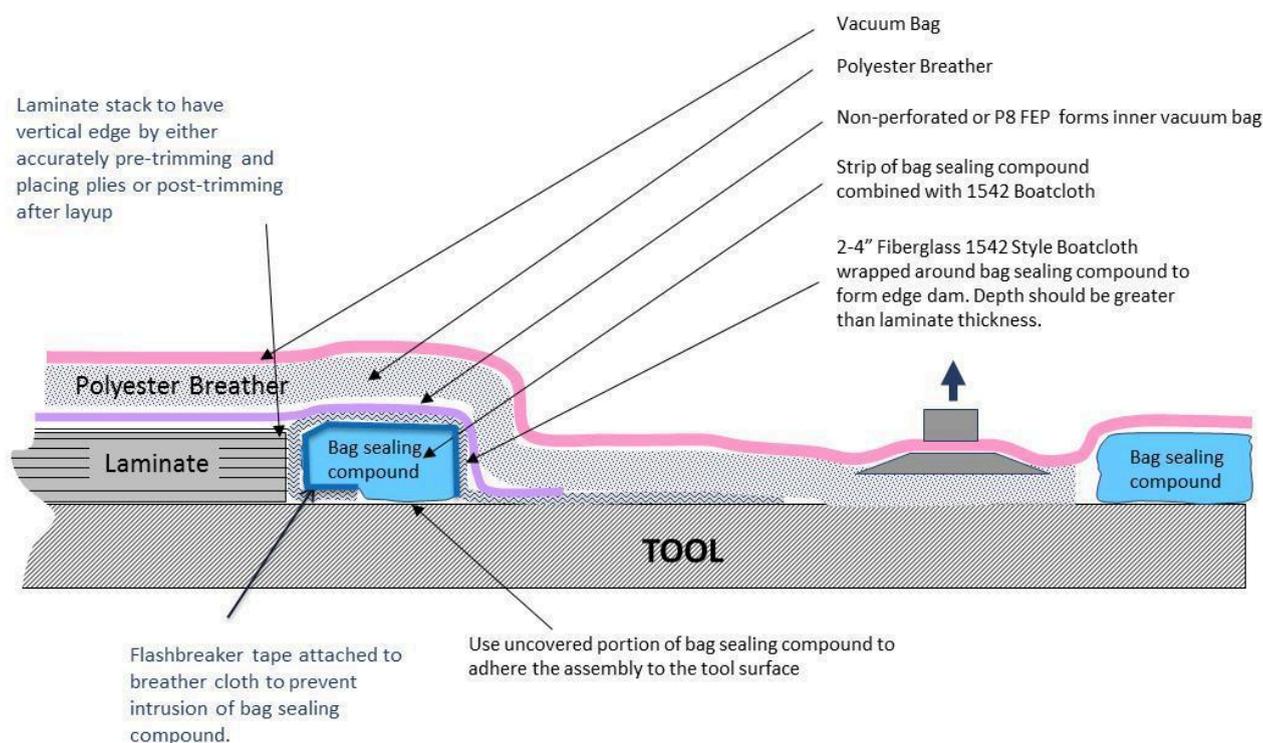
VACUUM REQUIREMENT

For vacuum bag only cures, vacuum should be less than 2" of Hg (68 mbar) of absolute vacuum for the given altitude. At sea level a minimum of 28" of Hg (948.2 mbar) is recommended. Shop vacuum is not recommended for use on VBO cured laminates.

LEAK CHECK

A vacuum leak check should be performed prior to cure and heat-up. The test should not be more than a 1" of Hg (34 mbar) vacuum loss in 10 minutes.

VACUUM BAG ARRANGEMENT FOR CURE



BAGGING MATERIAL NOTES

1. Any breather material may be used (e.g., A3000-4, A3000-7, 7781 glass, etc.) as long as it effectively removes the air and can withstand temperatures and pressures.
2. Non perforated solid release film is recommended although the use of perforated release film such as P8 is also possible.
3. The sealant tape and fiberglass cloth can be exchanged for cork, silicone or any other type of stiff dam as long as there are sufficient breather strings against the edges of the laminate that connect to the breather. The strings should have a twist in them and be placed on all edges between the dam and the laminate. Also note that the edge dams need to be higher than the laminate thickness.
4. Edge to be trimmed square unless lay-up produces a square edge.



VACUUM COMPATIBLE PROCESSING MATERIALS

The following materials are recommended for use with CYCOM 5320-1. For additional information please contact your Syensqo Composite Materials Representative.

Table 7 | Compatible Adhesive Materials and Surfacing Film

Film Adhesive	FM 209-1, FM 309-1, FM 300-2
Surfacing Film	SURFACE MASTER 905M

Table 8 | Processing Materials

Sealant Tape	SM5142, SM5153
Breather	A3000-4, A3000-7, Code 4819
Release Film	VacPak A6200, 0.001 inch or 0.0006 inch
Bagging Film	Vacfilm 450V, 0.002 inch or 0.003 inch
Flash Tape	Flash Tape 1, Flash Tape 2

DISPOSAL OF SCRAP MATERIAL

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

HEALTH & SAFETY

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

