HexPly® M21

180°C (*350°F*) curing epoxy matrix

Product Data

Description

HexPly® M21 is a high performance, very tough epoxy matrix for use in primary aerospace structures. It exhibits excellent damage tolerance, especially at high energy impacts.

HexPly® M21 is a toughened epoxy resin system supplied with unidirectional or woven carbon or glass fibers.

HexPly® M21 was developed as a controlled flow system to operate in environments up at 121°C *(250°F)*.

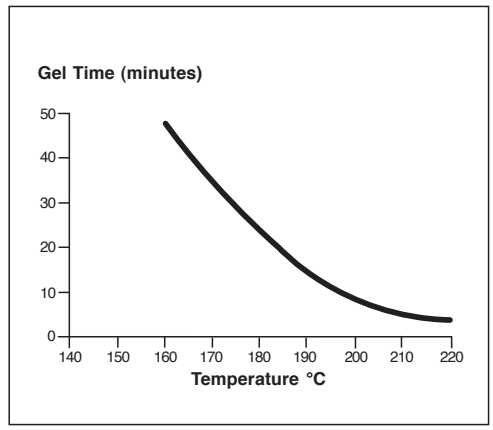
Benefits and Features

- Excellent toughness, in particular at high energy impact.
- High residual compression strength after impact.
- Effective translation of fiber properties, especially with intermediate modulus carbon fiber.
- Good hot-wet properties up to 150°C (*302°F*).
- Low exotherm behaviour allowing simple cures of thick structures up to 48mm *(1.89")*.
- Good tack life.

HexPly® M21 is best suited to press or autoclave cure to obtain optimum mechanical performance from the cured composite.

Resin Matrix Properties

Gel Time

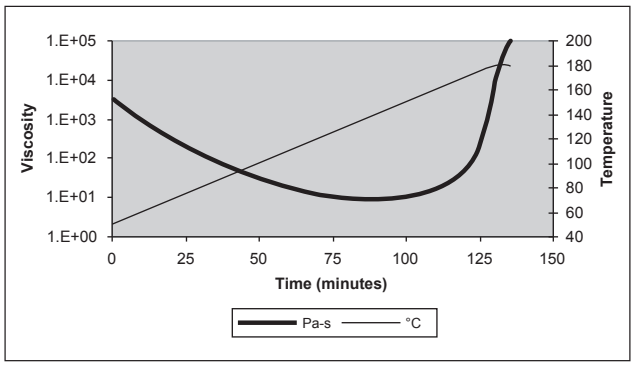


Cure Cycle Viscosity Profiles

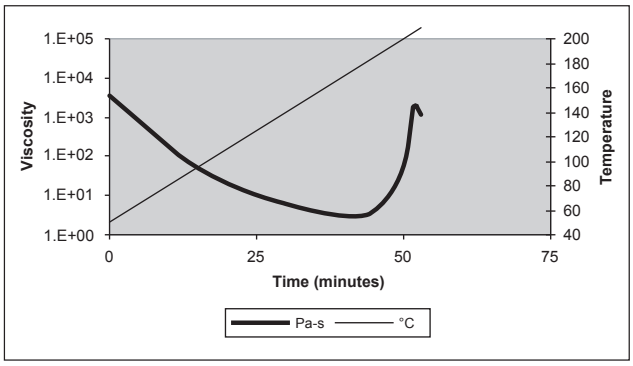
All experiments were made on an ARES-RDA Rheometer and correspond to the recommended cure cycles overleaf.

Typical Autoclave Cure Monolithic Part < 15mm *(0.6")* thick

1°C/min *(2°F/min)* heat-up rate

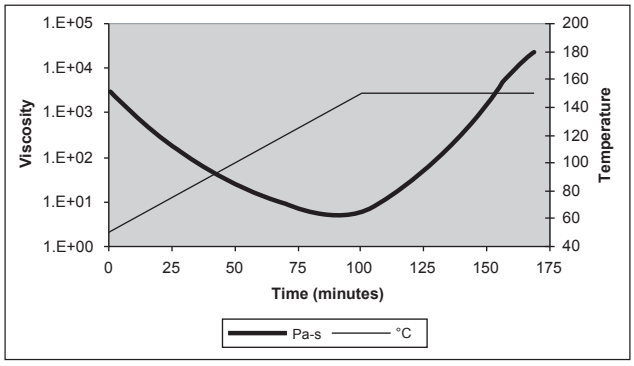


3°C/min *(5°F/min)* heat-up rate

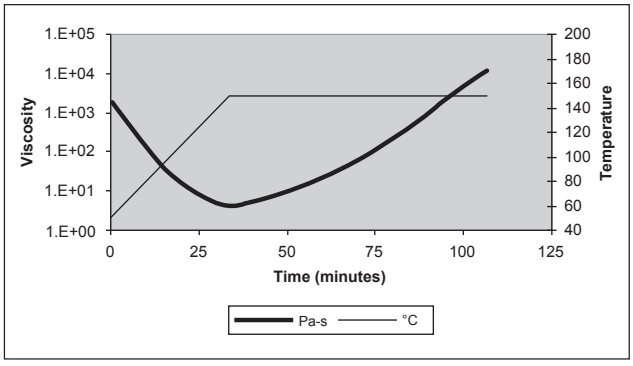


Typical Autoclave Cure Monolithic Part 15 - 48mm *(0.6-1.89")* thick

1°C/min *(2°F/min)* heat-up rate

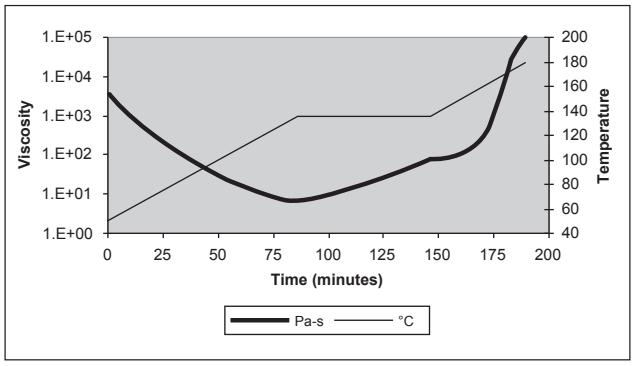


3°C/min *(5°F/min)* heat-up rate

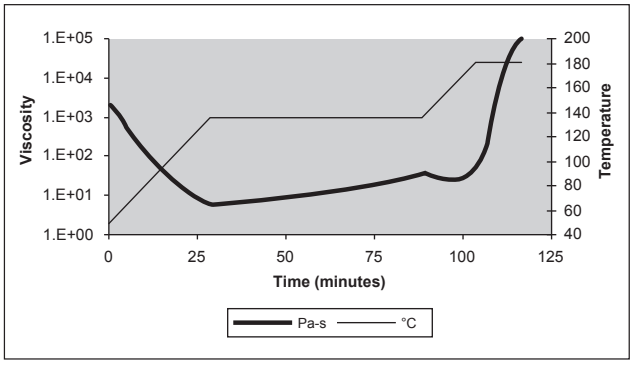


Typical Autoclave Cure Sandwich Parts

1°C/min *(2°F/min)* heat-up rate



3°C/min *(5°F/min)* heat-up rate



Prepreg Lay-up

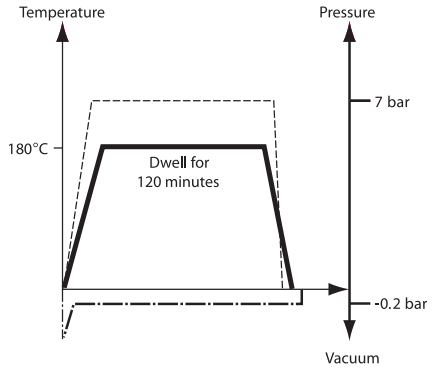
To achieve the best laminate quality, the 1st ply should be vacuum debulked to the mould at room temperature. Vacuum debulking of subsequent plies may be necessary to ensure removal of air trapped during the lay-up process. The frequency of debulking depends on part size and complexity.

Prepreg Curing Conditions

Defined heat-up rates will vary depending on the autoclave dimensions, the mass of tooling used and the size of the component to be manufactured.

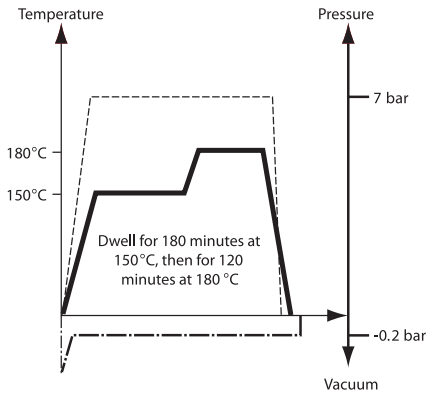
Typical Autoclave Cure Monolithic Part < 15mm *(0.6")* thick [1]

1. Apply full vacuum (1 bar).
2. Apply 7 bar gauge autoclave pressure.
3. Reduce vacuum to a safety value of –0.2 bar when the autoclave pressure reaches ~ 1 bar gauge.
4. Set heat-up rate from room temperature to 180°C ± 5°C (*356°F ± 9°F*) to achieve an actual component heat-up rate between 1-2°C/minute (*2-4°F/minute*).
5. Hold at 180°C ± 5°C (*356°F ± 9°F*) for 120 minutes ± 5 minutes.
6. Cool component at an actual cooldown rate of 2-5°C/minute (*4-9°F/minute*).
7. Vent autoclave pressure when the component reaches 60°C (*140°F*) or below.



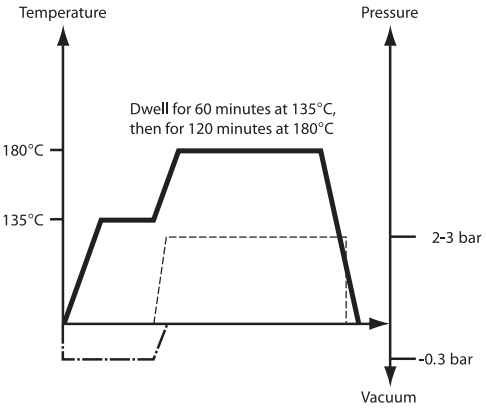
Typical Autoclave Cure Monolithic Part 15 - 48mm *(0.6-1.89")* thick [1]

1. Apply full vacuum (1 bar).
2. Apply 7 bar gauge autoclave pressure.
3. Reduce vacuum to a safety value of –0.2 bar when the autoclave pressure reaches ~ 1 bar gauge.
4. Set heat-up rate from room temperature to 150°C ± 5°C (*302°F ± 9°F*) to achieve an actual heat-up rate between 0.5-1°C/minute (*1-2°F/minute*).
5. Hold at 150°C ± 5°C (*302°F ± 9°F*) for 180 minutes ± 5 minutes.
6. Set heat-up rate from 150°C ± 5 °C (*302°F ± 9°F*) to 180°C ± 5 °C (*356°F ± 9°F*) to achieve an actual heat-up rate between 0.5 –1°C/minute (*1-2°F/minute*).
7. Hold at 180°C ± 5°C (*356°F ± 9°F*) for 120 minutes ± 5 minutes.
8. Cool component at an actual cool down rate of 2-5°C/minute (*4-9°F/minute*).
9. Vent autoclave pressure when the component reaches 60°C (*140°F*) or below.



Typical Autoclave Cure Sandwich Structure – Honeycomb or Foam [1]

1. Apply –0.3 bar maximum vacuum.
2. Do not apply autoclave pressure.
3. Set heat-up rate from room temperature to 135°C ± 5°C (*275°F ± 9°F*) to achieve an actual heat-up rate between 1-2°C/minute (*2-4°F/minute*).
4. Hold at 135°C ± 5°C (*275°F ± 9°F*) for 60 minutes ± 5 minutes.
5. After 60 minutes at 135°C (*275°F*), apply 2-3 bar gauge autoclave pressure (dependent on core density).
6. Remove vacuum when the autoclave pressure reaches ~ 1 bar gauge.
7. Set heat-up rate from 135°C ± 5°C (*275°F ± 9°F*) to 180°C ± 5°C (*356°F ± 9°F*) to achieve an actual heat-up rate between 1-2°C/minute (*2-4°F/minute*).
8. Hold at 180°C ± 5°C (*356°F ± 9°F*) for 120 minutes ± 5 minutes.
9. Cool component at an actual cooldown rate of 2-5°C/minute (*4-9°F/minute*).
10. Vent autoclave pressure when the component reaches 60°C (*140°F*) or below.



(1): As the cure cycle tolerance are related to the material, the temperature profile of the whole part must be kept within these tolerances. Thermocouples have to be applied to the component to guarantee that the temperature recording is representative of the actual experienced cure cycle of the component.

Cured Unidirectional Prepreg Properties

Nomenclature: resin/resin content by weight (%)/fiber weight (gsm)/fiber type

Physical Properties	Units	M21/34%/UD194/ IM7-12K	M21/34%/ UD194/ AS7-12K	M21/34%/ UD194/ IMA-12K
Fiber Weave/UD Fiber Mass	g/m²	IM7 UD 194	AS7 UD 194	IMA UD 194
Nominal Prepreg Mass	g/m²	294	294	294
Theoretical Calculated Cured Ply Thickness	mm *(inch)*	0.184 *(0.0072)*	0.184 *(0.0072)*	0.184 *(0.0072)*
Theoretical Calculated Fiber Volume	%	59.2	58.9	59.2
Resin Density	g/cm³ *(lbs/ft³)*	1.28 *(79.9)*	1.28 *(79.9)*	
Fiber Density	g/cm³ *(lbs/ft³)*	1.78 *(111.1)*	1.79 *(111.7)*	1.78 *(111.1)*
Theoretical Calculated Laminate Density	g/cm³ *(lbs/ft³)*	1.58 *(98.6)*	1.58 *(98.6)*	1.58 *(98.6)*

Mechanical Properties	Units	Temp °C *(°F)* dry	M21/34%/ UD194/ IM7-12K	M21/34%/ UD194/ AS7-12K	M21/34%/ UD194/ IMA-12K
Test Standards			U.S. Standards	European standards	
Glass Transition Temperature	°C *(°F)*	-	195 *(383)*	195 *(383)*	
Method			ASTM E1640	EN 6032 – DMA extrapolated onset E'	
Tension Strength	MPa *(ksi)*	23 *(73)*	2860 *(415)*	2350 *(341)*	3050 *(442)*
Tension Modulus	GPa *(msi)*	23 *(73)*	160 *(23.2)*	148 *(21.5)*	178 *(25.8)*
Method			ASTM D3039 (1)	EN 2561 B	
Compression Strength	MPa *(ksi)*	23 *(73)*	1790 *(260)*	1560 *(226)*	1500 *(218)*
Compression Modulus	GPa *(msi)*	23 *(73)*	148 *(21.4)*	123 *(17.8)*	146 *(21.2)*
Method			ASTM D695 (2)	EN 2850 B	
ILSS	MPa *(ksi)*	23 *(73)*	110 *(15.9)*	114 *(16.5)*	97 *(14.1)*
Method			ASTM 2344	EN 2563	
In-plane Shear Strength	MPa *(ksi)*	23 *(73)*	-	109 *(15.8)*	94 *(13.6)*
In-plane Shear Modulus	GPa *(msi)*	23 *(73)*	4.6 *(0.67)*	5.2 *(0.75)*	5.2 *(0.75)*
Method			ASTM D3039 (3)	EN 6031	
Open Hole Tension	MPa *(ksi)*	23 *(73)*	495 *(72)*	365 *(53)*	510 *(74)*
Method – (25/50/25) (gross section)			ASTM 5766 (5)	EN 6035 (4)	
Open Hole Compression	MPa *(ksi)*	23 *(73)*	303 *(44)*	315 *(46)*	305 *(44)*
Method – (25/50/25) (gross section)			ASTM D6484	EN 6036 (6)	
CAI @ 30.5J	MPa *(ksi)*	23 *(73)*	298 *(43)*	-	-
CAI @ 30.0J	MPa *(ksi)*	23 *(73)*	-	238 *(34.5)*	219 *(31.8)*
Method – (25/50/25)			ASTM D7136-D7137	EN 6038	

(1) Specimen dimensions: 12.7mm wide and 127mm free length *(0.5" wide and 5" free length)*
(2) Specimen dimensions: 80x12.7mm *(3.1"x0.5")*
(3) Specimen dimensions: 12.7mm wide and 127mm free length (+45/-45)s *(0.5" wide and 5" free length)*
(4) Specimen dimensions: 280x32 mm *(11"x1.3")*
(5) Specimen dimensions: 305x38mm and 6.35mm hole diameter *(12"x1.5" and 0.25" hole diameter)*
(6) Specimen dimensions: 132x32mm and 32 mm free length *(5.2"x1.3" and 1.3" free length)*

HexPly® M21

Cured Woven Prepreg Properties

Nomenclature : resin/resin content by weight (%)/reinforcement reference/width (mm)

Physical Properties	Units	M21/40%/285T2/ AS4C-6K	M21/35%/370H5/ AS4C-6K	M21/37%/7581	M21/45%/120	M21/56%/1080
Fiber Weave/UD Fiber Mass	g/m²	AS4C 2x2 twill 285	AS4C 5HS 370	E-Glass 8HS 300	E-Glass 4HS 105	E-Glass PW 48
Prepreg Mass	g/m²	475	569	476	193	109
Theoretical Calculated Cured Ply Thickness	mm *(inch)*	0.285 *(0.0112)*	0.343 *(0.013)*	0.235 *(0.009)*	0.106 *(0.004)*	0.066 *(0.0026)*
Theoretical Calculated Fiber Volume	%	55.8	60.2	50.0	38.4	28.2
Resin Density	g/cm³ *(lbs/ft³)*	1.28 *(79.9)*				
Fiber Density	g/cm³ *(lbs/ft³)*	1.78 *(111.1)*	1.78 *(111.1)*	2.56 *(159.8)*	2.56 *(159.8)*	2.56 *(159.8)*
Theoretical Calculated Laminate Density	g/cm³ *(lbs/ft³)*	1.56 *(97.7)*	1.59 *(99.1)*	1.92 *(119.9)*	1.77 *(110.5)*	1.64 *(102.4)*

Mechanical Properties	Units	Temp °C *(°F)* dry	M21/40%/285T2/ AS4C-6K	M21/35%/370H5/ AS4C-6K	M21/37%/7581	M21/45%/120
Glass Transition Temperature	°C *(°F)*		195 *(383)*			
Method			EN 6032 – DMA extrapolated onset E'			
Tension Strength	MPa *(ksi)*	23 *(73)*	885 *(128)*	880 *(128)*	444 *(64)*	320 (weft) *(46)*
Tension Modulus	GPa *(msi)*	23 *(73)*	67.6 *(9.8)*	73.9 *(10.7)*	25.5 *(3.7)*	24.8 (weft) *(3.6)*
Method			EN 2597 B		EN 2747	
Compression Strength	MPa *(ksi)*	23 *(73)*	835 *(121)*	820 *(119)*	692 (weft) *(100)*	674 (weft) *(98)*
Compression Modulus	GPa *(msi)*	23 *(73)*	59.7 *(8.6)*	63.9 *(9.3)*	-	-
Method			EN 2850 B			
ILSS	MPa *(ksi)*	23 *(73)*	70 *(10.1)*	70 *(10.1)*	75 *(10.8)*	60 *(8.7)*
Method			EN 2563		EN 2377	
In-plane Shear Strength	MPa *(ksi)*	23 *(73)*	97 *(14)*	94 *(14)*	99 *(14)*	-
In-plane Shear Modulus	GPa *(msi)*	23 *(73)*	4.2 *(0.61)*	4.8 *(0.70)*	4.4 *(0.64)*	-
Method			EN 6031			
Open Hole Tension	MPa *(ksi)*	23 *(73)*	340 *(49)*	375 *(54)*	-	-
Method – (25/50/25) (gross section)			EN 6035 (1)			
Open Hole Compression	MPa *(ksi)*	23 *(73)*	330 *(48)*	345 *(50)*	-	-
Method – (25/50/25) (gross section)			EN 6036 (2)			
CAI @ 30J	MPa *(ksi)*	23 *(73)*	276 *(40)*	270 *(39)*	-	-
Method – (25/50/25)			EN 6038			

(1) Specimen dimensions: 280x32mm *(11"x1.3")*
(2) Specimen dimensions: 132x32mm and 32mm free length *(5.2"x1.3" and 1.3" free length)*

Results for UD and Woven prepregs after an autoclave cure at 180°C *(356°F)* for 120 minutes.
Data normalised to Vf = 59% (0.184mm *(0.0072")* ply) for UD
Data normalised to Vf=56% (0.285mm *(0.0112")* ply) for 285T2 and Vf=60.5% (0.343mm *(0.013")* ply) for 370H5, to Vf = 50% for 7581
No normalization for ILSS and IPS (shear properties)
Woven samples tested in the warp direction.
Nominal cured ply thickness quoted is based on zero bleed and is determined using the fiber weight, resin content and resin & fiber density. Data quoted is for comparison only.

Prepreg Storage Life

Tack Life: 10 to 15 days at 23°C *(73°F)* dependent on lay-up process (hand lay-up, ATL, AFP)

Out Life: 30 days at 23°C *(73°F)*

Shelf Life: 12 months at –18°C (*0°F*) (from date of manufacture)

Definitions:

Tack Life: The time, at room temperature, during which prepreg retains enough tack for easy component lay-up.

Out Life: The maximum accumulated time allowed at room temperature between removal from the freezer and cure.

Shelf Life: The maximum storage life for HexPly® M21 Prepreg, upon receipt by the customer, when stored continuously, in a sealed moisture-proof bag, at –18°C *(0°F).* To accurately establish the exact expiry date, consult the box label.

HexPly® M21 prepregs should be stored as received in a cool dry place or in a refrigerator. After removal from refrigerator storage, prepreg should be allowed to reach room temperature before opening the polythene bag, thus preventing condensation (A full reel in its packaging can take up to 48 hours).

Precautions For Use

The usual precautions when handling uncured synthetic resins and fibrous materials should be observed, and a Safety Data Sheet is available for this product. The use of clean, disposable, inert gloves provides protection for the operator and avoids contamination of material and components.

Important

All information is believed to be accurate but is given without acceptance of liability. Users should make their own assessment of the suitability of any product for the purposes required. All sales are made subject to our standard terms of sale which include limitations on liability and other important terms.

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- RTM Materials
- Honeycomb Cores
- Carbon, glass, aramid and hybrid prepregs
- HexTOOL® composite tooling material
- Structural Film Adhesives
- Honeycomb Sandwich Panels
- Engineered Core
- Reinforcement Fabrics

For US quotes, orders and product information call toll-free 1-800-688-7734

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