

Product Description

ACG's VTM260 Series of epoxy resin matrices is a new generation of long outlife, flexible cure temperature formulations, which can be applied to a wide range of reinforcements and adapted to a wide range of low cost, vacuum-bag pressure, composite processes.

Within the series, formulations are specifically tailored to give good handling and processing characteristics on reinforcements ranging from lightweight veils to ultra heavyweight multi-axial fabrics, and from 100gsm to 900gsm unidirectional tapes. Formulations can also be selected for good handling characteristics under differing workshop ambient temperatures.

Each formulation has the same chemistry and will cure to the same final polymer structure; any combination of matrices in the series can be co-cured in a single moulding. This chemistry results in a component (or low cost tool) capable of withstanding dry service temperatures up to 120°C (248°F) and wet service temperatures up to 70°C (158°F).

The VTM260 series can be used for both component and tooling applications.

Features

- Outstanding vacuum-only processing capability for the widest scope of reinforcement formats.
- Flexible curing capability in a single prepreg system – low temperature i.e. 65-80°C (149-176°F) and medium temperature i.e. 80-130°C (176-266°F).
- Up to 30 days tack life at 21°C (70°F).
- 12 months freezer storage life.
- Free-standing postcure capability – Tg steps ahead of cure temperature.
- Excellent Tg development.
 - 128°C (262°F) DMA Tan• after 1 hour cure at 120°C (248°F)
 - 88°C (190°F) DMA Tan• after 16 hours cure at 65°C (149°F)
- VTM263 high viscosity, low flow variant, suitable for selective impregnation of fabrics or full impregnation of lightweight fabric reinforcements.
- VTM264 (and VTM264FRB) variants with intermediate viscosity and tack suitable for full impregnation of light and medium weight unidirectional and fabric reinforcements.
- VTM266 variant for full impregnation of ultra-heavyweight fabric reinforcements up to 2400g/m².

- VTM266-1 variant for heavy fabrics used in low workshop temperatures i.e. <20°C (68°F).
- VTA260 adhesive film available for manufacture of VTM prepreg skinned foam or Nomex honeycomb sandwich panels in a co-curing process. See Product data sheet
- All VTM 260 series resins can be laminated together and co-cured.

Instructions for Use

Thawing prepreg before use:

The prepreg should be removed from the freezer and allowed to thaw and fully reach room temperature before the seal on the storage bag is broken and the material is removed. Typically, the thaw time for a full 25m (82ft) roll of VTM260 series prepreg from storage at -18°C (0°F) is between 4 and 6 hours.

Note: The presence of moisture within a curing laminate may generate voids and thereby degrade the quality and aesthetic appearance of the structure produced. The level of degradation will vary and depend to a large extent on the specific processing route selected. Consequently it is prudent to ensure that prepreg of all types is thawed to the core of the roll before opening the sealed bag to avoid potential moisture contamination as a result of condensation.

Cutting prepreg:

Prepreg should be cut prior to removal of the release films. The balance of prepreg not required should be resealed and returned to the freezer although it is preferable to cut up complete rolls on the first removal from the freezer, subsequently storing shorter lengths in separate packs until required. Alternatively, the whole roll may be pre-cut into customised packs after thawing in order to store easily and reduce subsequent thawing time. Long outlife with this system means that material can be kept at RT in the workshop for extended periods, enabling improved materials management for manufacture of very large moulded components or tools.

Release agents:

The type of release coating or fabric selected can have a significant effect on both surface appearance and internal voids of cured laminates.

For vacuum bag oven-based processing, adhesive backed PTFE coated glass fabrics applied to the tool face provide the optimum conditions for air removal. Such fabrics are slightly microporous, which allows air to escape during cure. However, these fabrics are not easy to use. On flat or gently curving surfaces allowance needs to be made for the thickness of the release fabric and in complex geometry tools it may not be practical to drape the fabric into corners with small radii. Nevertheless, where practical, ACG strongly recommends the use of such fabrics to facilitate low internal void contents and fault free surfaces with a wide range of reinforcements and fibre volume fractions.

Silazane spray release agents (such as Frekote™ 700NC) are good release agents, which are easy to apply to the most complex tool shapes. The resultant surface is smooth however, and air may be trapped between the surface of the laminate and the surface of the tool if other precautions are not taken to provide paths for air to escape.

PTFE spray release agents have different surface tension characteristics to silazane and ACG has found a slight improvement in surface appearance compared to silazane under vacuum-only curing conditions. The effect, however, is insignificant compared to the influence of other process parameters.

Both silazane and PTFE release agents should produce acceptable surface finish when VTM260 series prepregs are cured under autoclave conditions.

Laying-up prepreg:

The release paper should be removed from the first ply, which should then be positioned into the carefully released mould. Great care should be taken to ensure that the prepreg conforms **exactly** to the tool shape, especially around the female corners to ensure consolidation without bridging.

Debulking during lay-up:

During lay-up, occasional debulking is often necessary to prevent bridging in corners and to ensure good consolidation over the whole surface area. Excessive debulking may however be detrimental in some lay-ups, causing resin flow and blocking the air channels which will be needed during the initial stages of cure. The lay-up should be vacuum debulked for approximately 2-3 minutes with 880-950mbar (26-28in Hg) of vacuum by covering the laid-up material with perforated release film (P3) plus a suitable breather and a low cost membrane. A general recommendation for debulking is after the first and every subsequent third ply, although it is recognised that this will vary dependant on component design and particular reinforcement configuration. For specific advice on the requirements for debulking, please refer to ACG's Technical department.

Bagging Consumables:

Once the required full laminate construction has been assembled, it should be prepared for curing as quickly as possible. The consumables pack for vacuum-only cure at any temperature up to 120°C (248°F) is as follows:-

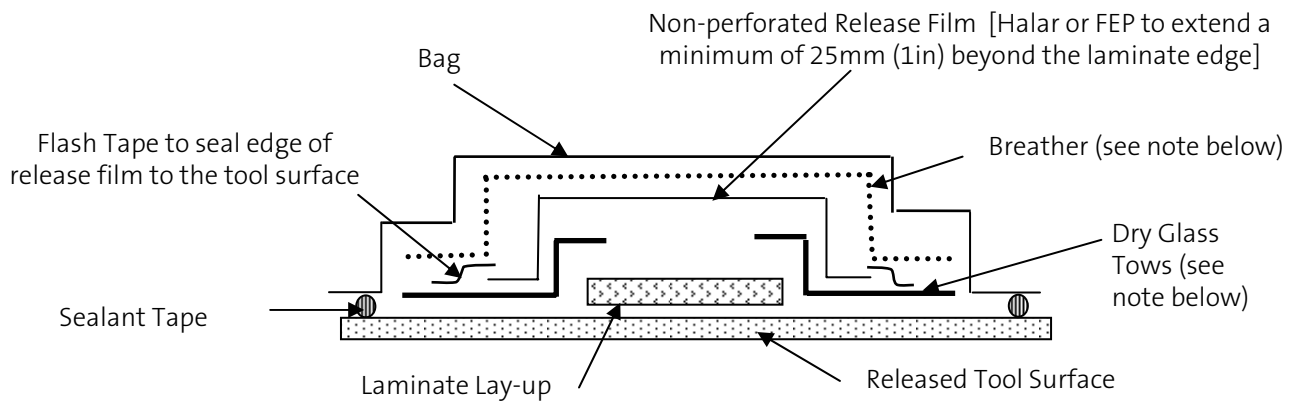
1. Apply 1 layer of non-perforated release film over the entire back face of the laminate and extending approx. 25mm (1in) beyond the edge of the lay-up.
2. Fit glass tows at approx. 0.5m (20in) intervals around the periphery of the lay-up such that they fit under the release film and over the lay-up edge by approx. 25mm (1in) and extend beyond the edge of the release film by approx 25mm (1in).
3. Apply 1 layer of heavyweight breather fabric over the entire lay-up. Extra plies may be fitted at valve positions as required. Special care should be taken to ensure that breather is fitted well into corners to prevent bridging in the curing laminate.
4. Apply the vacuum membrane.

During cure the highest available vacuum must be used – typically 980mbar (29in Hg). It is critical to ensure that the laminate itself is exposed to this vacuum by checking with a gauge at the opposite side of the laminate to the position of the vacuum port.

The consumables arrangement described is termed a “sealed bag” approach, which is recommended for processing VTM260 series materials either by vacuum-only or autoclave methods.

The basic bagging specification is presented schematically as follows:-

Fig 1: Basic Bagging Arrangement



Note: Glass Tows Detail

It has been shown to be beneficial to place dry glass tows at approx. 0.5m (20in) intervals around the edge of the laminate, to provide air paths under the release film into the breather layer as depicted above.

Note: Breather Detail

Vacuum or autoclave processing: - 1 ply of heavyweight breather 340g/m²NOM (10oz/sq.yd) is recommended

Note: Release Film Detail

The release film may be taped down to the tool surface with flash tape as required.

In autoclave processed conventional hot curing prepreg systems or in low fibre volume prepreg systems, edge dams or edge stops are often specified, especially in conjunction with caul sheets to ensure constant thickness or to prevent resin bleed. Such arrangements are not necessary with net resin vacuum processing of VTM systems but if they are used, care must be taken to provide clear air channels from the laminate to the vacuum line.

Resin selection

Prepreg Outlife, Handleability and Initial Cure Conditions:

	VTM263	VTM264	VTM266	VTM266-1
Vacuum-only moulded panel quality	< 2% voids	< 2% voids	< 2% voids	< 2% voids
Tack at 25°C (77°F)	Medium	Medium	High	Very High
Tack at < 15°C (59°F)	Low	Low	Low - Medium	Medium
Tack Life at 21±3°C (70±5°F)*	> 30 days	> 30 days	> 30 days	> 30 days
Minimum initial cure temperature (16 hours)	65°C (149°F)	65°C (149°F)	65°C (149°F)	65°C (149°F)
Tg after 16hrs at 65°C (149°F) – DMA onset	65°C (149°F)	65°C (149°F)	65°C (149°F)	65°C (149°F)
- DMA Tan •	88°C (190°F)	88°C (190°F)	88°C (190°F)	88°C (190°F)
Tg after 16hrs at 65°C (149°F) – DMA onset	100°C (210°F)	100°C (210°F)	100°C (210°F)	100°C (210°F)
- DMA Tan •	128°C (262°F)	128°C (262°F)	128°C (262°F)	128°C (262°F)

* The practical work-life at 21°C (70°F) depends on a number of factors, including reinforcement weight, degree of impregnation, cure temperature and cure pressure. Resin flow capabilities will gradually decrease during storage at 21°C (70°F). When curing under autoclave pressure the practical worklife will be greater than 30 days irrespective of the reinforcement. If curing under vacuum pressure the worklife may be reduced for heavier or partially impregnated reinforcements because the flow may be insufficient to fully wet the fibres. Worklife of VTM260 series prepregs is unlikely to be less than 21 days for any reinforcement.

Standard resins:

VTM266 and VTM264 (and VTM264FRB) are the standard resin systems in the VTM260 series. VTM264FRB is a black-pigmented flame retarded variant giving equivalent process and mechanical performance to VTM264 at no extra cost (see datasheet PDS1180).

As a guide, VTM264 and VTM264FRB should initially be considered for all weights and reinforcement types, but if any of the following criteria apply, VTM266 should be selected.

- **Full** impregnation of high weight reinforcements. (See table below.)
- Lay-up temperatures are below 18°C (64°F).
- High tack levels or low resin viscosities needed.
- Drape life of heavy weight reinforcements must exceed 3weeks.

Resin selector guide:

Resin	Glass UD	Carbon UD	Glass Woven	Carbon Woven
VTM266	<700gsm	<600gsm	>900gsm	>900gsm
VTM264	<400gsm	<300gsm	<900gsm	<900gsm

Specialised resins:

VTM266-1

Specifically design for very heavy weight reinforcement and for use in cold climates.

VTM263

Specifically designed for partial, or selective, impregnation of single or multi-layer fabric formats and particularly in ACG ZPREG® technology where near perfect finish is required under vacuum bag oven cure processing.

Typical Cure Cycles

Note: The following general statements should be noted related to the effects of cool down rates for component manufacture.

Cool Down after Initial Cure:

It is preferable to initially cool under vacuum only for all bagged applications. Autoclave pressure may be released at the onset of cool down. In general, for solid laminates, the vacuum may be vented and debagging commenced when part temperature has fallen by 20°C (36°F) from the specified cure temperature. Sandwich panels may require cooling to a lower temperature to avoid skin to core bond failure. Cooling to lower temperatures should also be adopted in any application where ultimate component accuracy is required.

Vacuum / Oven Cure:

The following basic cure cycle can be applied to all the VTM260 Series prepregs included in this datasheet.

- Apply 980mbar (29in Hg) vacuum at room temperature.
- Heat to 65°C -0/+2°C (149°F -0/+3.6°F) at a rate not exceeding 2°C (3.6°F) per minute (0.5°C/0.9°F is fully acceptable and usual for larger structures).
- Maintain at 65°C -0/+2°C (149°F -0/+3.6°F) under the applied vacuum for 16 hours.
- Cool at 3°C (5.5°F) per minute maximum under vacuum, venting the vacuum as appropriate in accordance with the statement above.
- Demould part.

Note: VTM260 Series prepregs can be cured at temperatures up to 120°C (248°F) and recommended cure times are provided later in this datasheet. There are recommendations on the thickness of laminates that can be moulded at temperatures higher than 65°C (149°F); contact ACG Technical department for advice.

Autoclave Cure:

The following basic cure cycle can be applied to all the VTM260 Series prepregs included in this datasheet.

- Apply 980mbar (29in Hg) vacuum at room temperature and maintain throughout the cure.
- Heat to 65°C -0/+2°C (149°F -0/+3.6°F) at a rate not exceeding 2°C (3.6°F) per minute (0.5°C/0.9°F is fully acceptable and usual for larger structures).
- Normally pressure should be initiated as the leading thermocouple reaches 65°C (149°F).

Note: In cases where very high mass tooling causes slower heat up rate or the heating capability of the autoclave is slow, pressurisation should be commenced one hour from onset of heating.

- Pressure should be set to 90psi or the maximum recommended where a core is being used.
- Care should be taken to control the heat up rate during pressurisation to avoid risk of exotherm during possible temperature overshoot.
- Maintain at 65°C -0/+2°C (149°F -0/+3.6°F) under the applied vacuum for 16 hours.
- Cool at 3°C (5.5°F) per minute maximum under vacuum, venting the vacuum as appropriate in accordance with the statement above.
- Demould part.

VTM260 Series Recommended Cure Times and Tg Development:

Cure Temperature	Recommended Cure Time	Developed Tg (TMA)
65°C (149°F)	16 hours	88°C (190°F)
80°C (176°F)	5 hours	103°C (217°F)
100°C (212°F)	2 hour	122°C (252°F)
120°C (248°F)	1 hour	128°C (262°F)

Note: 65°C (149°F) is the minimum cure temperature for the VTM260 range of prepregs. The times and temperatures quoted above can be generally used for all products in the VTM260 range. For minimum cure conditions for any of these prepregs, refer to ACG's Technical department who will be happy to advise based on part design and tooling route selected.

Postcure

Laminates cured for the recommended period at elevated temperatures may be used up to 20°C (36°F) below that temperature in service without additional postcure.

In applications demanding maximum temperature or environmental resistance e.g. 120°C (248°F) service, it is essential to develop the glass transition temperature of the resin to the maximum level. This may be achieved by using the full, recommended postcure noted below.

Note: The following statements should be noted related to the effects of heat up and cool down rates for component manufacture.

Postcure - Heat Up Rate:

Parts may be loaded into a pre-heated oven set at the original cure temperature. Typically, a heat up rate of 20°C/hr (36°F/hr) is appropriate.

Postcure - Cool Down Rate:

Rapid cool down may be employed. Open the oven doors after switching off the heating to assist cooling. The part(s) may be removed from the oven when they can be safely handled.

- Heat from room temperature to 120 ±2°C (248 ±3.5°F) at 20°C (36 °F) per hour.
- Dwell at 120 ±2°C (248 ±3.5°F) for 0.5 hours, as measured by the lagging thermocouple attached to the laminate.
- Cool as noted above to room temperature. This postcure cycle will result in a Tg of approximately 128°C (262°F).
- Laminates may be postcured unsupported unless the size, shape and laminate thickness would allow excessive distortion under self-weight, in which case some minimal support is desirable.

Technical Data

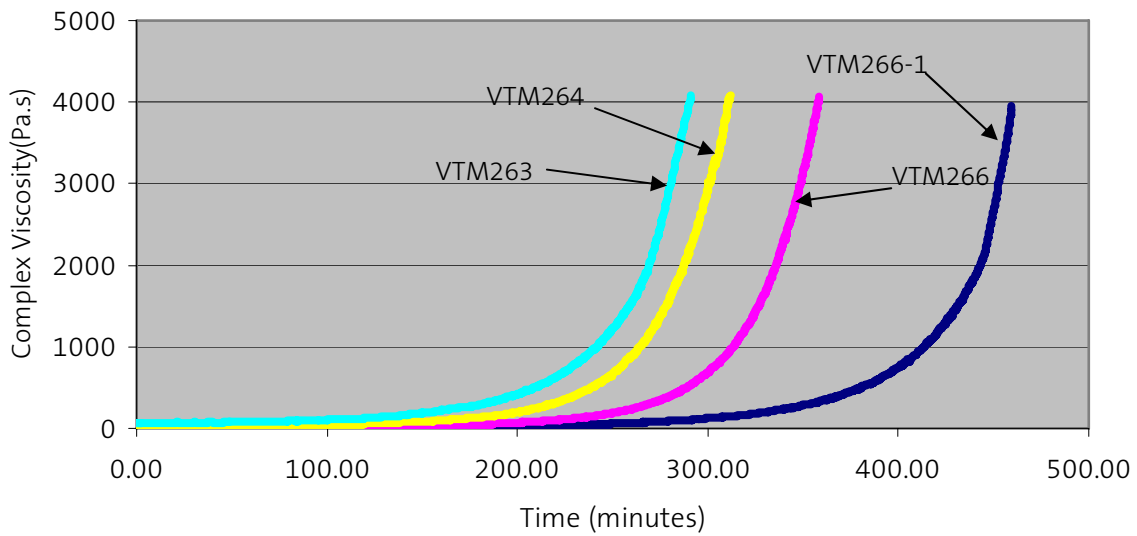
Matrix Resin Properties:

Cured Resin Property:	VTM260 Series
Cured resin density g/cm ³ (lb/ft ³)	1.19 (74.5)

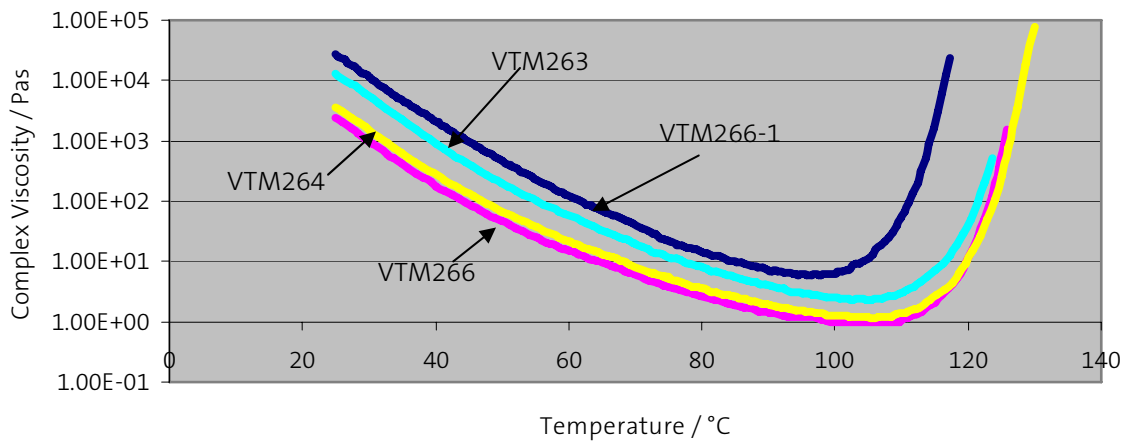
Viscosity:

The following isothermal viscosity profiles cover the VTM260 series.

**VTM260 SERIES ISOTHERMAL COMPLEX
VISCOSITY AT 65°C (149°F)**



VTM VISCOSITIES



Typical Mechanical Properties

Mechanical properties for VTM266 UD prepregs. Other products in the VTM range are expected to give similar performance with the same reinforcing fibres.

	VTM266	VTM266	VTM266
Fibre	T700S (24K) UD	34-600(48K) UD	M46J
Fibre Weight	300gsm	900gsm	300gsm
Actual Vf	54	60	53
Initial OVBC	16 hrs at 65°C (149°F)	16 hrs at 65°C (176°F)	5 hrs at 80°C (176°F)
Postcure	None	None	None
ILSS			
0° Strength (MPa)	84.30	82.9	82.2
Flexural Properties			
0° Strength (MPa)	1677	1859	1503
0° Modulus (GPa)	110	131	222
Tensile			
0° Strength (MPa)	2459	2773	1877
0° Modulus (GPa)	118	131	228.2
Strain-to-Failure (%)	2.07	1.73	0.84
Poisson's Ratio	0.32	0.34	
Compression			
0° Strength (MPa)	1102	1371	790
0° Modulus (GPa)	107	127.6	199.5
Poisson's Ratio	0.34	0.34	0.32
In Plane Shear			
Strength (MPa)	83.60		56.4
Modulus (GPa)	4.07		3.44

Mechanical properties for VTM260-series with woven glass and carbon reinforcements. Other products in the VTM range are expected to give similar performance with the same reinforcing textiles

Actual Vf Initial OVBC Postcure	VTM266	VTM266	VTM264
	CF0100	CF1100	GFM001
	T300(3k)-283gsm- 4x4 Twill	T300(6k)-410gsm- 2x2 Twill	E-glass-162gsm- 2X2 Twill
	50	50	50
	5 hrs at 80°C (176°F)	5 hrs at 80°C (176°F)	5 hrs at 80°C (176°F)
	None	None	None
ILSS			
Warp Strength (MPa)	71.40	54.80	
Flexural Properties			
Warp Strength (MPa)	971	656	
Warp Modulus (GPa)	55.1	45.5	
Tensile			
Warp Strength (MPa)	700	632	440
Warp Modulus (GPa)	60	57.3	27.7
Strain-to-Failure (%)	1.17	1.11	1.59
Poisson's Ratio	0.08	0.07	
Compression			
Warp Strength (MPa)	541	389	
Warp Modulus (GPa)	54.1	50.4	
Poisson's Ratio	0.08	0.07	
In Plane Shear			
Strength (MPa)	95.50	79.20	
Modulus (GPa)	3.87	3.01	



Mechanical properties for VTM264 with carbon and glass stitched multiaxial fabrics. Laminates were prepared with fibre [+45,-45]_n, they were tested in both fibre directions and both ±45 directions. The results in the attached table represent the average of the two fibre directions and the average of the two ±45 directions in each case.

Actual Vf Initial OVBC Postcure	VTM264	VTM264
	CFM001	GF1400
	T700S(12k)-400gsm- ±45° biaxial	E-glass-445gsm- ±45° biaxial
	50	50
	5 hrs at 80°C (176°F)	5 hrs at 80°C (176°F)
	None	None
ILSS		
Fibre 0/90 -Strength (MPa)	49	56
Fibre ±45 - Strength (MPa)	48	40
Flexural Properties		
Fibre 0/90 -Strength (MPa)	900	525
Fibre ±45 - Strength (MPa)	220	390
Fibre 0/90 -Modulus (GPa)	50	21
Fibre ±45 - Modulus (GPa)	14	9
Tensile		
Fibre 0/90 -Strength (MPa)	1024	180
Fibre ±45 - Strength (MPa)	150	300
Fibre 0/90 -Modulus (GPa)	57	26
Fibre ±45 - Modulus (GPa)	14	13

Availability

ACG VTM260 Series prepregs are available in a wide range of reinforcing fabrics and unidirectional tapes including glass, carbon, aramid and hybrids. Materials can also be supplied in a range of formats including fully impregnated prepregs, sided versions and packaged stacks for RFI processing. For full recommendations on the optimum materials format to suit a design application and processing conditions, please refer to ACG's Technical department.

The VTM260 Series product range is available from both ACG's UK and US sites.

Storage

ACG VTM260 Series prepregs should be stored wrapped and sealed in polythene at -18°C (0°F). The storage life of the prepreg under these conditions is at least 12 months.

Health and Safety

ACG VTM260 Series prepregs contain epoxy resin, which can cause allergic reactions by skin contact. Avoid prolonged or repeated contact with skin. Gloves and protective clothing must be worn.

Wash the skin thoroughly with soap and water or resin removing cream after handling. Do not use solvents for cleaning the skin.

Use mechanical exhaust ventilation when heat curing the resin system.

For further information consult the following ACG Material Safety Data sheets:-

VTM263	MSDS350
VTM264	MSDS338
VTM266	MSDS339
VTM266-1	MSDS340

Exotherm

Note: You are advised to read this section before proceeding with initial cure.

VTM260 series prepregs are reactive formulations, which can undergo severe exothermic heat build up during the initial curing process if incorrect curing procedures are followed.

Great care must be taken to ensure that safe heating rates, dwell temperatures and lay-up / bagging procedures are adhered to, especially when moulding solid laminates in excess of 10mm (0.4in) thickness. The risk of exotherm increases with lay-up thickness and increasing cure temperature. It is strongly recommended that trials, representative of all the relevant circumstances, are carried out by the user to allow a safe cure cycle to be specified. It is also important to recognise that the model or tool material and its thermal mass, combined with the insulating effect of breather / bagging materials can affect the risk of exotherm in particular cases. Please contact Advanced Composites Group Technical department for further information on exotherm behaviour of these systems.