

Product Description

LTM45-1 is a toughened low temperature curing epoxy prepreg matrix resin capable of high temperature end use. LTM45-1 has been specifically developed to give improved vacuum bag process ability with very low void content. The matrix also provides improved tack and handling characteristics compared to LTM45EL. LTM45-1 can be supplied on a variety of woven and unidirectional carbon, glass and aramid reinforcements and is suitable for autoclave, vacuum bag or press moulding.

Features

- Low initial cure temperature (minimum 55°C/131°F) and the Tg steps ahead of the cure/postcure temperature
- More rapid cure at higher temperatures
- $\geq 210^{\circ}\text{C}$ (410°F) Tg after suitable postcure
- Good mechanical properties
- Improved Health and Safety – No resin transfer during lay-up
- Solvent free
- Processable by vacuum bag, autoclave or press moulding
- Wide vacuum-only processing window to achieve void contents normally below 0.5%
- 180°C (356°F) capable structural parts mouldable directly from low cost, low temperature moulds plus freestanding postcure route.
- Ideal for minimum cost prototype and short production run parts from low cost moulds
- Improved moulding accuracy compared to conventional high temperature cure prepreg systems.

Instructions for use

Thawing prepreg before use:

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 prepreg from storage at -18°C (0°F) is between 4-6 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. It may be advantageous therefore to order roll lengths or cut pieces to suit each particular application.

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, and 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.

Release agents:

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

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 internal void contents well below 0.5% and fault free surfaces with a wide range of reinforcements and fibre volume fractions.

Silazane spray release agents (such as Frekote™ 700NC) are easy to apply to the most complex tool shapes. The resultant surface is smooth, however 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. The effect, however, is insignificant compared to the influence of other process parameters.

Laying-up prepreg:

The release paper should be removed from the first ply, which should then be positioned into the carefully released mould. On fabric lay-ups the first ply should be cut slightly larger than all the remaining plies to optimise extraction of air during the early part of cure. Great care should be taken to ensure that the prepreg conforms **exactly** to the tool shape, especially around female corners to ensure consolidation without bridging. In addition it should be noted that LTM45-1 on woven fabric will tend to have increased tack on one side of the prepreg. The tackier side should always be placed against the tool for the first ply, and subsequent plies laid up with the resin rich side positioned onto the less tacky side of the previous ply.

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 to 3 minutes with 880-948mbar (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.

Bagging consumables:

Once the required full laminate construction has been achieved, it should be prepared for curing as quickly as possible. The consumables pack for autoclave cure is as follows:-

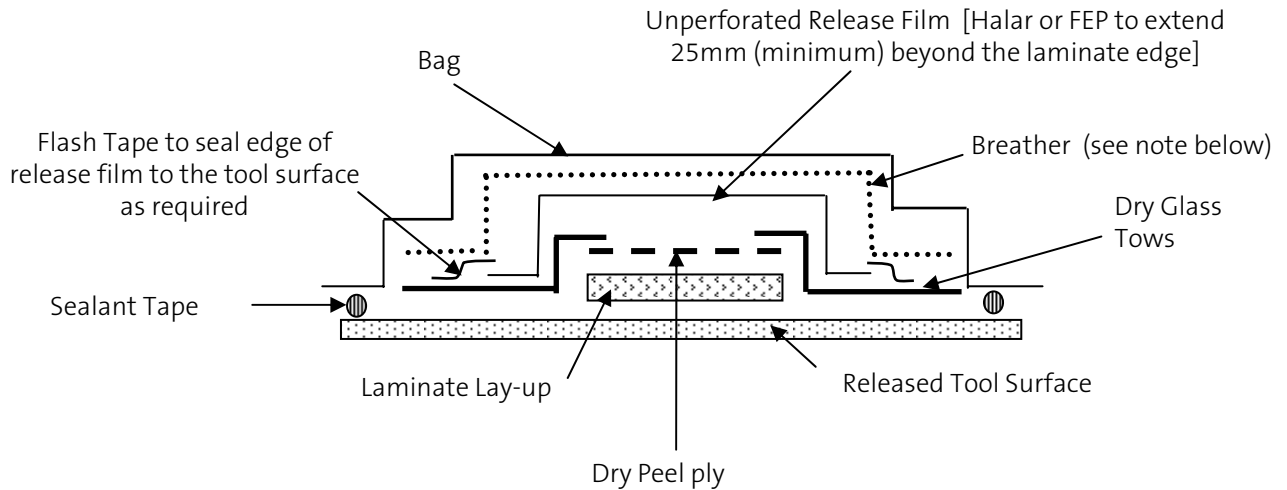
1. Apply 1 ply of approximately 80gsm dry polyester peel ply cut to the laminate size.
2. Apply 1 layer of non-perforated release film over the entire back face of the laminate and extending approximately 25mm (1in) beyond the edge of the lay-up.
3. Fit glass tows at 0.5m (20in) intervals around the 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).
4. Apply 1 layer of heavyweight non-woven breather fabric over the entire lay-up. Extra plies may be fitted at valve positions as required.
5. Apply the vacuum membrane.

During cure the highest available vacuum must be used – typically 982mbar (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.

This consumables arrangement is termed a “sealed bag” approach, which is recommended for processing LTM45-1 either by autoclave or vacuum only methods.

The basic bagging specification is presented schematically below:-

Fig 1: Basic Bagging Arrangement



It has been shown to be beneficial to place dry glass tows at 50cm (20in) intervals around the edge of the laminate, to provide air paths under the release film into the breather layer as shown above.

Note: Breather Details

Vacuum only or autoclave processing:- Heavyweight breather 340gsm (12oz type), 1 ply recommended

Note: Release Film

The release film should be taped down to the tool surface with flash tape as required, i.e. at folds or creases.

In autoclave processed conventional hot curing prepreg systems or in low fibre volume prepreg systems, edge dams or edge stops have often been 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 LTM systems but if they are used, care must be taken to provide clear air channels from the laminate to the vacuum line.

Note: The LTM45-1 low temperature system is highly reactive and therefore sensitive to quite small changes in the ambient temperature. When large structures are to be built, which may take several days to prepare, the worklife of the laid up LTM45-1 prepreg may be exceeded prior to elevated temperature cure. In such cases longer outlife prepreg systems may be preferred. Please contact ACG Technical Department for advice on material selection.

Exotherm

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

LTM45-1 is a reactive formulation 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 5mm (0.2in) thickness. The risk of exotherm increases with lay-up thickness and increasing cure temperature, and 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.

Typical Cure Cycles

Vacuum Cure for LTM45-1:

Apply 982mbar (29in Hg) vacuum at room temperature.

Heat to $65 \pm 2^{\circ}\text{C}$ ($149 \pm 3.6^{\circ}\text{F}$) at between 2°C (3.5°F) and 3°C (5.5°F) per minute.

Maintain at 65°C (149°F) under the applied vacuum for 16 hours.

Cool to room temperature at 3°C (5.5°F) per minute under vacuum.

Vent vacuum at room temperature.

Demould part.

Autoclave Cure for LTM45-1:

Apply 982mbar (29in Hg) vacuum at room temperature and maintain this throughout cure.

Heat to $65 \pm 2^{\circ}\text{C}$ ($149 \pm 3.6^{\circ}\text{F}$) at between 2°C (3.5°F) and 3°C (5.5°F) per minute.

Normally pressure should be initiated as the leading thermocouple reaches 55°C (131°F) (which is the minimum recommended cure temperature consistent with a cure time of 24 hours).

NB: In cases where very high mass tooling causes slower heat up rate or the heating capability of the autoclave is slow, start not less than 30 minutes and not greater than 1 hour from onset of cure.

Pressure should be set to 90psi or the maximum recommended where a core is being used.

Care should be taken not to exceed a heat up rate of 3°C (5.5°F) per minute during pressurisation to avoid risk of exotherm during possible temperature overshoot.

Dwell at 65 ±2°C (149 ±3.6°F), at full pressure for 16 hours.

Cool to room temperature at 3°C (5.5°F) per minute under pressure.

Depressurise and remove component.

Prepreg Outlife and Initial Cure Conditions:

	LTM45-1
Out life at 21°C (70°F) *	5 – 6 days
Minimum initial cure temperature (24 hours)	55°C (131°F)
Overnight initial cure temperature (16 hours)	65°C (149°F)
Tg after 65°C (149°F) cure	75°C (167°F)

Note: Maximum recommended heating rate is between 2°C (3.5°F) and 3°C (5.4°F) per minute

* Fresh material with no accumulated out time

The 5-6 day outlife noted will give essentially zero void content laminates during **autoclave** processing. LTM45-1 can be processed successfully under vacuum only conditions to give near pit-free surfaces, but the outlife window for successful production of parts with very low void content is, to date, not fully defined. During the outlife period the resin viscosity will increase, and the minimum mouldable temperature may therefore also need to be increased.

If you are processing this material by vacuum-only methods, please refer to ACG Technical Department for full details on outlife and initial cure recommendations.

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 resistance e.g. 180°C (356°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 as follows:-

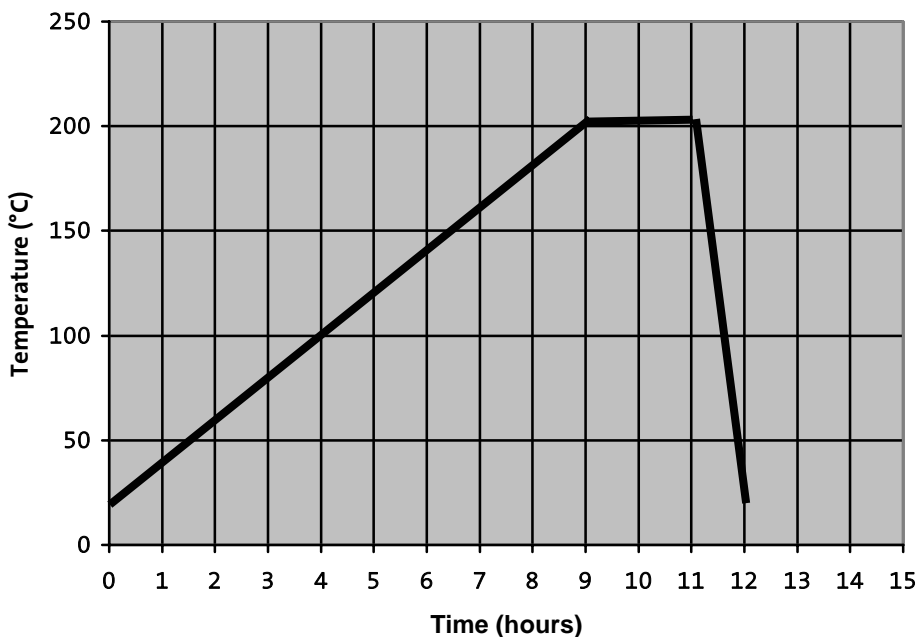
Heat from room temperature to 200 ±2°C (392 ±3.6°F) at 20°C (36°F) per hour maximum.

Dwell at 200 ±2°C (392 ±3.6°F) for 2 hours as measured by the lagging thermocouple attached to the laminate.

Cool at 3°C (5.5°F) per minute to room temperature. This will result in a Tg of approximately 200-205°C (392-401°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.

Fig 2: LTM45-1 Postcure Cycle to achieve maximum Tg



Notes:

- A. Maximum Ramp Rate 20°C (36°F) per hour
- B. Dwell for 2 hours at 200°C (392°F)
- C. Maximum Rate of Cool Down from 200°C (392°F) to 20°C (68°F) is 3°C (5.5°F) per minute
- D. Part may be removed at <60°C (140°F)

Alternative postcure schedules may be used to achieve intermediate levels of cure, which may be adequate for lower service temperatures. Please contact the Advanced Composites Group Technical department.

Technical Data

Matrix Resin Properties:

Cured resin density
 Tg after 16 hours / 65°C (149°F)
 Tg (dry) after postcure of 2 hours at 200°C (392°F)
 Tg (wet) after postcure of 2 hours at 200°C (392°F)
 (24hour water boil)

Value

1.24g/cm³ (77.41 lb/ft³)
 75°C (167°F)
 200-205°C (392-401°F)
 120°C (248°F)

Typical Laminate Properties

Tenax HTA (12K) – 145gsm - 59% Vf (32%rw) unidirectional 0° prepreg cured at 65°C (149°F) for 16 hours under vacuum bag pressure only, postcured freestanding at 175°C (347°F) for 2 hours.

	Method	LTM45-1		Retention
Ult. Compression Strength 21°C (70°F)	ASTM 3410 Celanese	1476 MPa	214.07 ksi	-
Compression Strength after impact (Quasi-isotropic UD lay-up) 21°C (70°F)	SACMA SRM2-88	122 MPa	17.70 ksi	-
Ult. Flexural Strength 21°C (70°F)	ASTM 790	1664 MPa	241.34 ksi	-
Ult. Flexural Strength 120°C (248°F) after 24 hours in boiling water	ASTM 790	1494 MPa	216.69 ksi	89.8%
Flexural Modulus at 21°C (70°F)	ASTM 790	119 GPa	17.26 Msi	-
Flexural Modulus at 120°C (248°F) after 24 hours in boiling water	ASTM 790	125 GPa	18.13 Msi	105%
Interlaminar Shear at 21°C (70°F)	CRAG 100	95.5 MPa	13.85 ksi	-
Interlaminar Shear at 120°C (248°F) after 24 hours in boiling water	CRAG 100	52.1 MPa	7.55 ksi	54.6%
Laminate Void Content		0.2% to 0.4%		-

Availability

LTM45-1 prepreg is available in a wide range of reinforcing fabrics and unidirectional tapes including glass, carbon, aramid and hybrids.

LTM45-1 is available from both our US and UK sites.

Storage

LTM45-1 series prepreps should be stored, wrapped and sealed in polythene at

-18°C (0°F). The storage life of the prepregs under these conditions is at least 6 months although prepregs nearing the end of their storage life may exhibit some reduction in worklife.

Health and Safety

LTM45-1 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 ACG Material Safety Data Sheet no. 183.

