Gurit

PRODUCT PROCESSING GUIDE

SPRINT™

www.gurit.com

SPRINT™

KEY POINTS SUMMARY

1. DESCRIPTION

The dry fibers in SPRINT allow full and even air evacuation from the component resulting in high laminate quality with no time consuming vacuum de-bulks or autoclave processing.

2. STORAGE

- Long term –Frozen at – 18°C
- Short term <2-4 weeks - De-frosted at room temperature dependent on system
- Surface films see TDS for defrosted outlife data
- Support rolls by the tube on 'A' frame, do not allow rolls to lie flat or premature wet out may occur
- Once defrosted, premature wet out can be extended by unrolling and storing flat

3. HANDLING

- Health & Safety- protect skin from resin contact
- Health & Safety - be aware, dry fibres may become airborne when cutting Sprint
- Defrosting – ensure fully defrosted prior to removing any wrapping materials

4. WORKSHOP

- Temperature 15-25°C
- Humidity <70% RH

5. TOOLING

- Capable of withstanding cure temperature
- 90-100% Vacuum tight – tested prior to use

6. PRODUCT APPLICATION

- Choose resin content product as appropriate for monolithic or core bonding application
- Lay-up neatly without bridging
- Observe overlaps carefully
- ENSURE AIR PATHS from each ply to the vacuum stack
- Use correct vacuum consumables for low resin flow and temperature

7. CURING

- >95% Vacuum level, <5% drop over 5 minutes test
- Ensure even heating rate and correct dwell/cure temperature and time
- Careful de-moulding once cooled below 50°C

8 . RECORDS

- Careful QC record keeping of material and process parameters

1. DESCRIPTION

SPRINT consists of a fibre reinforcement either side of a pre-cast, thermosetting resin film. The material therefore has the appearance of dry reinforcement which has resin concealed at its centre. A tack film is applied to one side to aid positioning. Single Sided SPRINT comprises of a single layer of reinforcement with resin film on one side.

The dry fibers in SPRINT allows air evacuation from the component resulting in high laminate quality without the need for time consuming vacuum de-bulks or autoclave processing. SPRINT is processed at elevated temperature under vacuum in a similar way to prepreg, however there are some key processing differences as explained in this document.

This guide provides generic information for the processing of Gurit Epoxy SPRINT with emphasis on the most popularly used ST94, ST95, ST90 and ST130FR resin systems.

2. STORAGE

2.1 Long Term

Check product data sheet for shelf life at -18 °C. When not being used, prepreg should be stored at -18°C to maximize shelf life. In frozen storage the SPRINT should be tightly sealed in its plastic sleeve and in the original box or stillage.

2.2 Short Term

Once defrosted the material will start to age more quickly, the data sheet for the individual product will give un-frozen outlife. The material should be supported by the cardboard tube to prevent weight bearing on the rolled material. An ‘A-Frame’ storage rack is the best option. Standing rolls on end may cause ‘telescoping’ of the product and should be avoided if possible. Unused product should be wrapped in plastic and returned to frozen storage. A record of time spent unfrozen should be kept for each roll.

2.3 Unfrozen Shelf Life

In the same way as Prepreg resin, SPRINT will age when de-frosted at room temperature, with SPRINT there is the additional factor of fibre wet-out which starts to occur when not frozen. The resin has been formulated to have good cold-flow resistance, but eventually the resin will impregnate the fibre reducing the air breathing ability.

The un-frozen (defrosted) shelf life of SPRINT products is the time at room temperature that the resin system remains chemically active and will flow and cure as intended. Beyond this time the flow will be reduced and laminate quality can be compromised.

The SPRINT Life of the product is slightly different and refers to the time before the resin permeates into the reinforcement and wets it out. If this happens the material will still cure properly but will not have the breathing ability that is essential for void free laminates.

The SPRINT life is very dependent on temperature, reinforcement type, resin content (%) and storage condition. SPRINT life will be extended if the unfrozen material is unrolled and stored flat in cool conditions.

The SPRINT life is shorter than the chemical shelf life and is the time stated on the datasheets.

3. HANDLING

3.1 Health and Safety

Safety Data Sheets (SDS) are available on request from Gurit Technical Support, which detail all applicable risk phrases. Gurit recommends these are consulted and COSHH assessments carried out before using any SPRINT products.

Protective clothing should always be worn when handling SPRINT products. In general skin contact should be avoided when handling uncured or partially cured SPRINT, by wearing suitable nitrile gloves and change as often as required.

Large rolls can be very heavy, the weight should be checked before handling, and manual handling aids used if required.

3.2 Defrosting

Rolls of SPRINT should be removed from the freezer storage in sufficient time to allow them to warm up to lay-up temperature before they are used. For most rolls an overnight defrost will suffice, however large rolls may take longer. The rolls of SPRINT should always be supported by their cardboard tube in the box or stillage.

Prior to removing the polythene sleeve it is essential that the temperature of the SPRINT is in excess of the dew point temperature in order to avoid condensation on the SPRINT surface. The dew points for a given relative humidity and air temperature are given in Table 1.

Any moisture condensing on the SPRINT can potentially cause wrinkling of backing paper and may influence interply adhesion.

AIR TEMPERATURE °C	50%R.H.	60%R.H.	70%R.H.	*80%R.H.	*90%R.H.
15	4.7°C	7.3°C	9.5°C	11.5°C	13.4°C
20	9.3°C	12.0°C	14.4°C	16.4°C	18.3°C
25	13.8°C	16.7°C	19.1°C	21.3°C	23.2°C
30	18.4°C	21.4°C	23.9°C	26.2°C	28.2°C

Table: 1 Dew Point Temperature

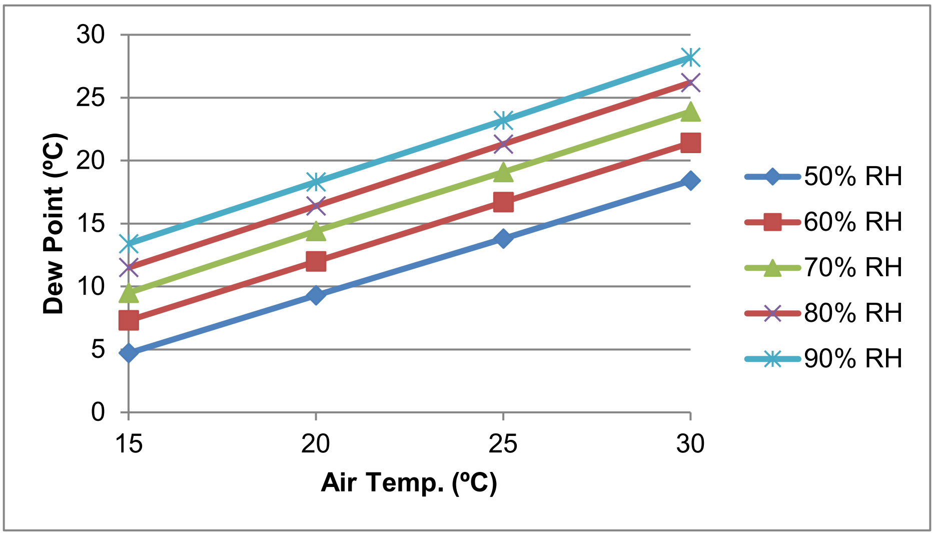

Figure: 1 Dew Point vs Temperature and Humidity

3.3 Cutting

SPRINT can be cut with a knife blade or similar using straight edge for guide. Scissors are only practical for very lightweight reinforcements and will become contaminated with resin quite quickly. Keep cutting tools clean and sharp and observe Health and Safety considerations. SPRINT can be kitted from templates and stored flat until use, keep backers in place until use in the mold.

Automated cutting machines can be used, optimum speed and blade settings may vary, and will have to be adjusted according to prepreg type and weight. Ultrasonic blade systems are generally used on cutting beds.

As with cutting any product with dry glass or carbon fibers, some fragments may become airborne, ensure workers are protected from these by active ventilation or personal respirator.

4. WORKSHOP CONDITIONS

4.1 Temperature

SPRINT is best laid up in room temperature conditions 15-25°C. Lower temperatures will reduce tack and drape (flexibility) of the product and make layup more difficult. Higher temperatures can make the resin very sticky and difficult to re-position during layup, the resin will also be more likely to prematurely wet out the fibers, shortening the SPRINT life.

4.2 Humidity

Ideally humidity should be low to help prevent condensation. It is good practice to keep humidity below 70%RH.

4.3 Contamination

Avoid sources of airborne contamination such as oil mist, release agents any sources of silicones etc.

5. TOOLING

5.1 Materials

The tool should be constructed from materials that will retain their dimensional stability at the intended processing conditions. Consider cure temperature of the resin system, -1 bar pressure and the number of parts required from the tool. Considerations should also be made for the thermal properties of the tool, thermal conductivity, thermal mass, and coefficient of thermal expansion. Ideally the coefficient of thermal expansion of the tool should be matched to the coefficient of thermal expansion of the component being made e.g. carbon part = carbon tool.

For some structures it will be necessary to have a significant amount of heat flow through the tool from the underside. If this is the case the tool must allow sufficient air flow over the rear face and any support structure must be designed with this in mind.

Cored tools will usually have significant insulating qualities meaning that there may be a significant temperature lag at the laminate to tool interface. Bear this in mind when designing the tooling.

5.2 Structure

Any joins in the mould need to be sealed and airtight as tooling leaks can be responsible for low quality or scrap parts. The design should incorporate as few joins as possible and where necessary should incorporate good sealing systems such as rubber O rings.

5.3 Surface

The surface finish will depend on the requirements of the part but needs to be non -porous and treated with a good release system. Vacuum integrity should be checked before any parts are made; surfaces may be sealed with high temperature lacquer/coating system such as Duratec.

Release agents need to be capable of withstanding the intended cure temperatures, wax is generally not used with prepreg; semi-permanent products from companies such as Chemtrend, Frekote, Zyvax, are generally favoured and should be applied according to the manufacturers' recommendations. PTFE adhesive film provides a good pinhole free release surface but as it is micro-porous, vacuum bags should be sealed to the tool outside of the PTFE film.

5.4 Tool Validation

Before building parts, the mould should be vacuum tested through the intended cure cycle. This will ensure that vacuum integrity is maintained even when the mould and support frame expands at temperature.

Vacuum Level must exceed an absolute minimum of 95% (approx. 900 mbar) and target vacuum drop should be less than 5% over 10 minutes.

During this stage a detailed map of mould temperatures should be made in order that cold or hot spots can be identified and corrected. SPRINT requires even and controlled heating in order to provide quality parts and uniform curing.

6. Surfacing Methods

6.1 Surfacing Films

Gurit produce a range of lightweight surfacing films that are designed to provide good quality surface for SPRINT laminates that will in turn provide a good base for a painted finish system.

PRODUCT	RESIN FILM (G/M²)*	COLOR	COMMENT	USE WITH
SFG75-90	150	Light green	Toughened, Paintable	ST90 (70°C Cure)
SF80	150	Light green	Toughened, Paintable	ST 95, ST94 (ST90 cure at 85°)
SF80FROBL	100	Black	Opaque black fire-retardant film	ST95, ST94 (ST90 cure at 85°)
SF130FR	200	Dark Grey	Opaque dark-grey fire retardant film	SE130FR, ST130FR
SF75-90	300	Dark Grey	Sandable, Ideal for post painting. Pinhole free	ST90 (70°C Cure)
SF96	300	Dark Grey	Sandable, Ideal for post painting. Pinhole free	ST95, ST94 (85°C Cure)
SF95 VH	300	Dark Grey	Abrasion resistant	ST 95 ST94 (ST90 cure at 85°)

Table: 2 Surface Films

* Note the surfacing films contain two 70g/m² fine weave glass carrier scrims. The total weight of the film is therefore 140g plus the resin weight.

All SPRINT surface films (SF) aim to reduce pin holes on the surface of components to be painted.

SF75-90 and SF96 are highly filled SPRINT surface films making for easier sanding and improved print blocking characteristics from laminate reinforcement; ideal for high class painted surfaces. The cured colour of SF75-90 and SF96 is dark grey and not transparent.

SFG75-90 and SF80 are lighter-weight resin-based SPRINT surface systems, which protect the laminate when abrading but more ideally suited to parts which do not require such a high-quality finish. These products can provide a resin rich surface to protect the laminate and reduce water ingress. The cured colour of SFG75-90 and SF80 is light green and translucent.

6.2 Process Coat

There are epoxy process coat options from Gurit such as CR3400, designed to provide an easy to sand surface for subsequent painting operations. These are applied into the mould by roller or brush and require a top-coat system to protect from U.V. and weathering.

The limited overcoating time means that these products only suitable for specific applications. Contact Gurit Technical Support for information on these products.

7. SPRINT PRODUCT APPLICATION

The key parameters for successful SPRINT use are;

- Neat and accurate layup of the material avoiding bridging and creasing
- Good air paths from the dry fabric of the SPRINT to the vacuum stack

7.1 Surfacing Film

The surface films are essentially lightweight breathable Single Sided SPRINT products and have a partially impregnated fine reinforcement layer. The breathable surface provides a smooth defect free surface.

The outlife stated on the Technical Data Sheet should be observed for optimum performance.

The surface film is usually applied with the 'tacky side '(paper side) against the tool, it is important to ensure that the backer is completely removed from 'under' the film as it is positioned. It is very difficult to re-position as it will distort if removed so great care is needed to position correctly. Use a wide soft brush or rubber squeegee to smooth out any air bubbles trapped underneath. Many users like to use a brief vacuum de-bulking process to ensure good mould adhesion and air removal from the surface film. This is useful if heavy reinforcements are applied on the surface film on vertical or over-hanging surfaces.

Overlaps should be kept as small as possible; butt joints can be used but are difficult to ensure complete gap-free coverage.

Figure: 2 Example of Surface Film Application.

7.2 SPRINT layup

Structural SPRINT with two reinforcement layers is provided with a light tack film on one face, this face has the backer material and is laid up tacky side down. Single Sided SPRINT is laid up resin side down, carefully remove the backer from the resin film as the product is laid down. It is essential to check backers to ensure 100% clean removal.

Whether full length or pre-cut pieces, the application of SPRINT is straight forward. The product only needs gentle firming into position additionally, heat from hand or heat gun can be used to tack the material in place. Tight radii and corners may have to be cut-in, to allow the material to conform (See section 7.3). Overlaps should be kept neat and small approximately 30-50mm.

SPRINT does not normally need to be de-bulked between layers to produce high quality laminates. It can be used to produce thick laminates quickly and easily. However, some high thickness complex moldings may benefit from one or more de-bulks in order to maintain a tidy lay up (See Section 7.3). Typical de-bulk for Sprint will be approximately 5 minutes for smaller parts and 15 minutes for large parts, in order to consolidate the material without encouraging wet out.

For vertical and overhead surfaces with heavy weight laminates it may be necessary to consider the effects of gravity causing the laminate creep down the vertical surface. A form of clamp may be required to hold the laminate in place when not laminating to avoid the laminate falling off the vertical surface. Alternatively consider mold design to include a center split to reduce vertical surfaces. Workshop temperature will affect product tack and therefore influence the adhesion of the laminate to the mold,

7.3 De-lofting

SPRINT users should be aware of the material's tendency to de-loft as it cures. Typically, the material is approximately twice as thick during layup as it will be when cured as the resin migrates from the distinct film into the reinforcement. In typical thin laminates this is of little consequence but in areas of higher thickness and curved geometry the de-lofting may result in excess material ('ears') forming over male contours or bridging in female contours (See Figure; 2 and 3 below). Adding a quick de-bulk may be beneficial to reduce the thickness of the uncured laminate. Internal corners should be cut and overlapped to prevent bridging, heavy consolidation by hand into corners might make the material conform but may risk locking off air paths. It's beneficial to cut and overlap and allow the materials to slip slightly during the impregnation and de-loft stage.

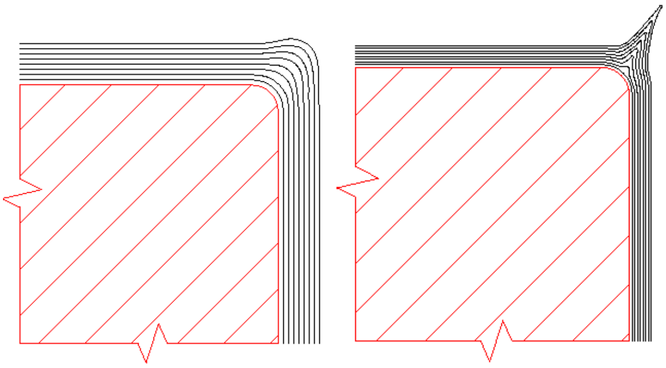

Figure: 3 Potential 'ears' caused by de-lofting on outside corners

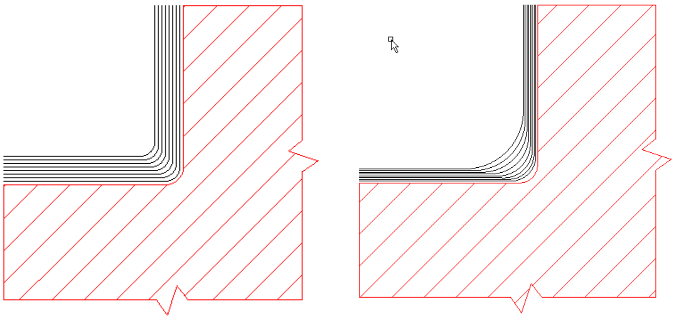

Figure: 4 Potential bridging caused by de-lofting on inside corners

7.4 SPRINT Breathing

In order to get the best from SPRINT it is essential to allow air paths from the individual plies. This can be done by adding 'breather tows' between the plies that are connected with the vacuum stack. Alternatively, if practical, the plies can be staggered by 3-5mm such that the edge of each ply is in connection with the vacuum stack. As shown by redlines in Figure 5. Avoid isolating layers from the vacuum thicker laminate where 'buried' plies may not have good access to edge or breather tow air paths.

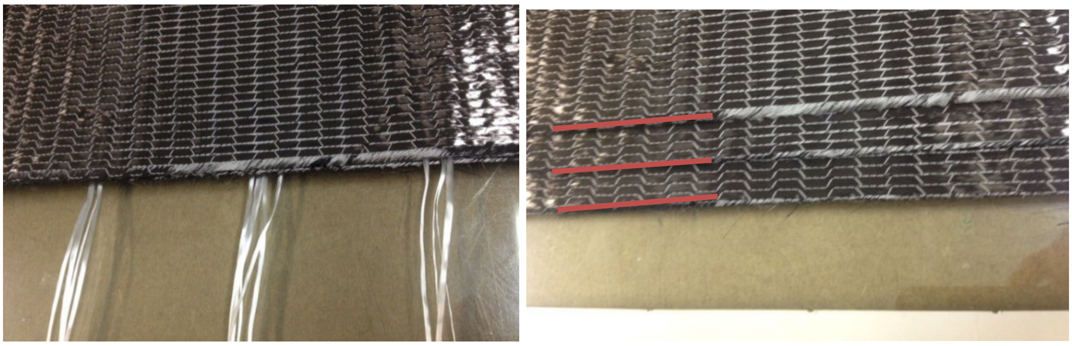

Figure: 5 Glass tows between plies to aid breathing and staggered edge method

7.5 Vacuum Consumables

Once the SPRINT lamination is completed, the vacuum consumables and bag are fitted. In most cases this will be;

1) Peel Ply – Scoured Nylon (eg. Stitch Ply A 85g/m²), protects surface and provides perfect surface for secondary bonding. Do not compromise on peel ply quality as it can affect interply adhesion.
2) Perforated Release film – Low Bleed version such as RP2 controls resin flow whilst allowing a small amount of air breathing
3) Breather Material – 150-300gsm provides air evacuation path and bleeder for resin

Spray adhesive can be used to hold these consumables in place.

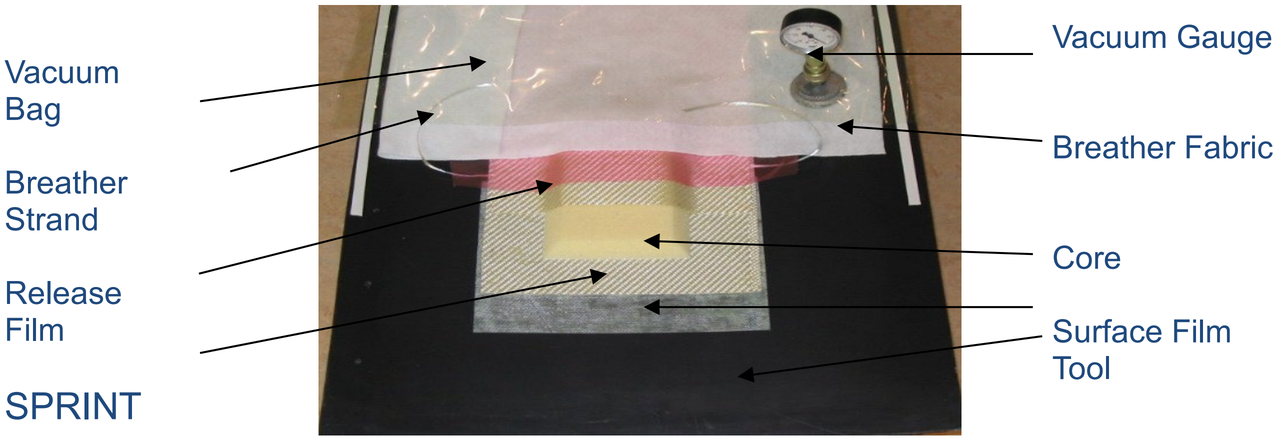

Figure: 6 General Lay-up Materials

Large components (example >3x3m) require additional air flow medium such as infusion mesh because the breather fabric can crush and reduce vacuum levels and consolidation to the middle of parts. This does not need to cover the complete surface but should form a grid as example below. A peripheral vacuum channel further helps maintain an even vacuum pressure across the whole part.

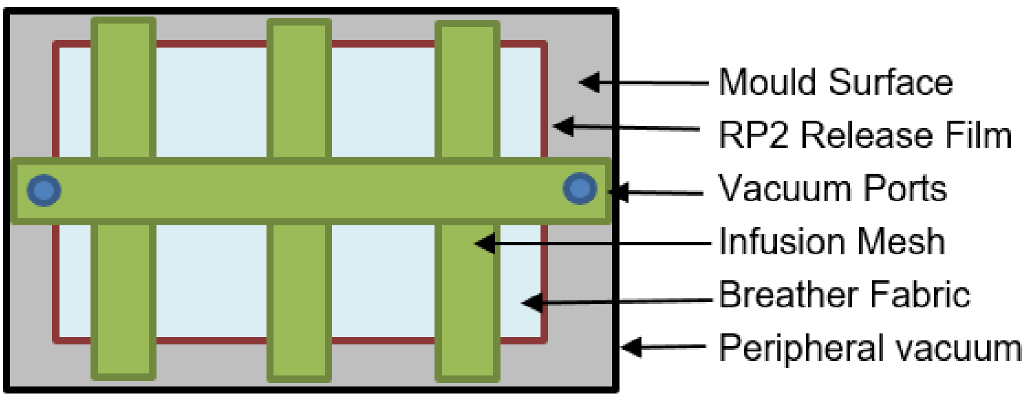

Figure: 7 Additional Vacuum Distribution Materials

The chosen vacuum bag material needs to be capable of withstanding the cure temperature and any excessive exotherm produced during cure. Typically, a nylon based vacuum bag film capable of 200°C is used. A suitable high temperature vacuum tape should also be used.

7.6 Core Materials

Corecell is the recommend foam core as it is capable of withstanding the normal processing temperatures, has low resin absorbency and does not out-gas. The use of perforated core (Pin Hole, PH) allows air/resin flow. Alternatively, "Double Cut" format allows some additional flexibility to curved component whilst allowing for air/resin flow.

CORE	MAXIMUM PROCESSING TEMPERATURE (°C)	SUITABILITY FOR CO-CURING
Corecell M or T	120	Yes
Gurit PVC HT	120	Possible outgassing (Test panel required)
PET	130	Yes
Balsa	120	No unless extremely dry or epoxy sealed
Other PVC	Depends on grade	Possible outgassing (Test panel required)
Honeycomb	180	Yes with certain precautions

Table: 3 Core Selection

Some PVC cores can evolve gas that will reduce consolidation levels of the skin. Additionally, the gasses liberated by the curing temperatures can have a chemical effect on the adhesive film/resin and hinder the cure this can lead to very poor core bonding properties.

PET core can have higher resin up take than other cores, this needs to be taken into account when processing where more resin will be needed - see below.

Honeycomb needs to have a low moisture content to prevent excessive vapour pressure in the cells during processing. The use of SA75-90 or SA80 adhesive film is required to prevent excessive bleed of the SPRINT resin into the cells.

If using large cell size honeycomb there may be insufficient compaction pressure during cure to promote complete wet out of the SPRINT dry fabric adjacent to the centre of the cell. Therefore, it is advised to manufacture representative test panels using the chosen honeycomb and SPRINT laminate to ensure that suitable quality can be achieved.

7.6.1 Three Hit Processing

If making cored parts in a three-hit sequence, the mould/first laminate is laid up and cured. Prior to core bonding the peel ply is removed and the surface prepared. Then the core is bonded under vacuum. The second laminate is then laid up and cured as an independent step. This method generally has the lowest processing risk but is more time and energy consuming.

7.6.2 Two Hit Processing

In this method, the first laminate and core are applied and co-cured together. There is slightly more risk but is quicker. This is the most often used method.

7.6.3 One Hit processing

Here the first laminate, core and second laminate are all laid up, consolidated and cured under one bag in one operation. It requires very accurate core placement/kitting and carries the highest processing risk. This is often only carried out on simple components or volume production where process has been refined.

7.6.4 Core bonding

There are three possibilities for bonding the core.

1) In a three hit process the core can be bonded with a wet epoxy core bonding system such as SP568.
2) More usually, SPRINT laminates are bonded to the core with adhesive film such as SA75-90 or SA80. These are toughened adhesive films with controlled flow characteristics. Film weights of 250- 400g/m²

adhesive film are generally used for core bonding applications. They are laid up onto either the core or laminate. Applying to the core makes for much easier core placement as it becomes effectively self-adhesive. When processing honeycomb cores the adhesive film and its carrier scrim prevent excessive resin from entering the cells, this needs to be spiked to allow gasses to escape the cells.

3) Another option is to use additional resin in the SPRINT to bond the core. For this application, high resin content SPRINT products are available. For example, standard glass SPRINT resin content is 40% compared to core bonding Glass SPRINT resin content c.50%. Users should satisfy themselves that sufficient resin is available for core bonding and filling of core cut pattern.

A combination of the above three methods can be used as is convenient.

7.6.5 Core bond resin requirements

Different core types, densities and cut patterns will each have their own resin requirements for successful bonding. It is important if using cut (flexible) foam that the resin/glue film fills all the cuts, otherwise the core properties can be compromised.

CORE	MINIMUM ADHESIVE RESIN REQUIREMENTS ON ESSENTIALLY FLAT PANELS
Corecell M80-M200 PH	250g per face
PVC 80-200 kg PH	250g per face
PET 80-200 kg PH	400g per face
Corecell M80-M200 DC (knife cut)	400g per face (20-25mm sheets - increasing with thicker sheets)

Table: 4 approximate amounts of resin required

It is extremely important to make representative test panels to ensure adequate adhesive/Sprint resin is provided for adequate core bond. It is important that in addition to ensuring enough resin is available, the cure profile allows the resin to reach a low enough viscosity to flow and fill all the core gaps i.e. laminate heating rates and temperatures should be fast and high enough (see section 8.3)

With scrim backed core, double cut and triple cut, the radius of the mould has a huge impact on the resin uptake. Additionally thick foam core will often insulate and reduce the ability for heat transfer and therefore resin flow into the core. If double layer of core are required in large parts, the importance of these points is magnified and representative test panels MUST be made to ensure sufficient resin and flow is achieved.

Thermoformed perforated core will provide the lowest resin uptake whilst maintaining core properties.

7.6.6 Core Splicing using Mono-component Pastes

For edge to edge core splicing, gap filling, and corner consolidation, Gurit produce a range of catalytic curing pastes that are applied from cartridge. These are stored frozen as with SPRINT and need to be completely de-frosted prior to use.

Figure 8 SP4832 & MP75-90 Monocomponent paste being used.

7.7 Unidirectional Materials

SPRINT cannot be made with unidirectional reinforcements because the UD fibres allow insufficient air paths. However, SPRINT can be laid up and co–cured with conventional UD prepregs with similar curing requirements e.g. ST 90 SPRINT with SE75 prepreg. In certain cases, UD plies can be interleaved with SPRINT to negate the need for de-bulks in the UD. If thick UD stacks are required it is not usually advisable to de-bulk them in-situ with SPRINT materials as this compromises the breathability of SPRINT plies. It may be possible to pre-consolidate the UD plies and insert the consolidated stack into the lay-up.

8. CURING

8.1 Autoclaves

SPRINT is designed to produce good quality laminates *without* the need for autoclave pressures during curing. However, there is no reason why SPRINT cannot be cured in an autoclave. SPRINT products are generally made with higher resin content than prepreg in order to allow some flow and bleed in ordinary vacuum processing. In an autoclave there will be much more resin flow and vacuum consumables will need to be changed to suit. Otherwise autoclave procedure will be the same, respecting the cure recommendations of the SPRINT resin matrix.

8.2 Vacuum Curing

Before curing, thermocouples need to be attached to various parts of the laminate including mid plies (if possible).

All temperatures discussed below refer to laminate temperatures not oven temperatures

The oven should be thermally mapped with tool in-situ to determine even temperature profile.

Important points;

- Curing vacuum level
- Ramp rate
- Intermediate dwell temperature (equilibration dwell/ exotherm dwell)
- Cure temperature
- Cure time

8.2.1 Vacuum Requirements

Prior to cure a vacuum drop test should be completed to ensure >95% vacuum level is achieved and a drop test of less than 5% in 5 minutes. Lower vacuum levels may result in less consolidation and higher void content, therefore reducing overall laminate quality.

The component may benefit from being placed under vacuum at ambient temperature for a period of time before the cure is started.

8.2.2 Ramp Rates

- A ramp rate of the laminate between 0.3 and 3°C/minute is suitable for all SPRINT products;
- Ramp rates lower than 0.3°C/minute may not allow the resin viscosity to drop sufficiently for optimum flow. See Figure below.
- Faster rates may risk exotherm.

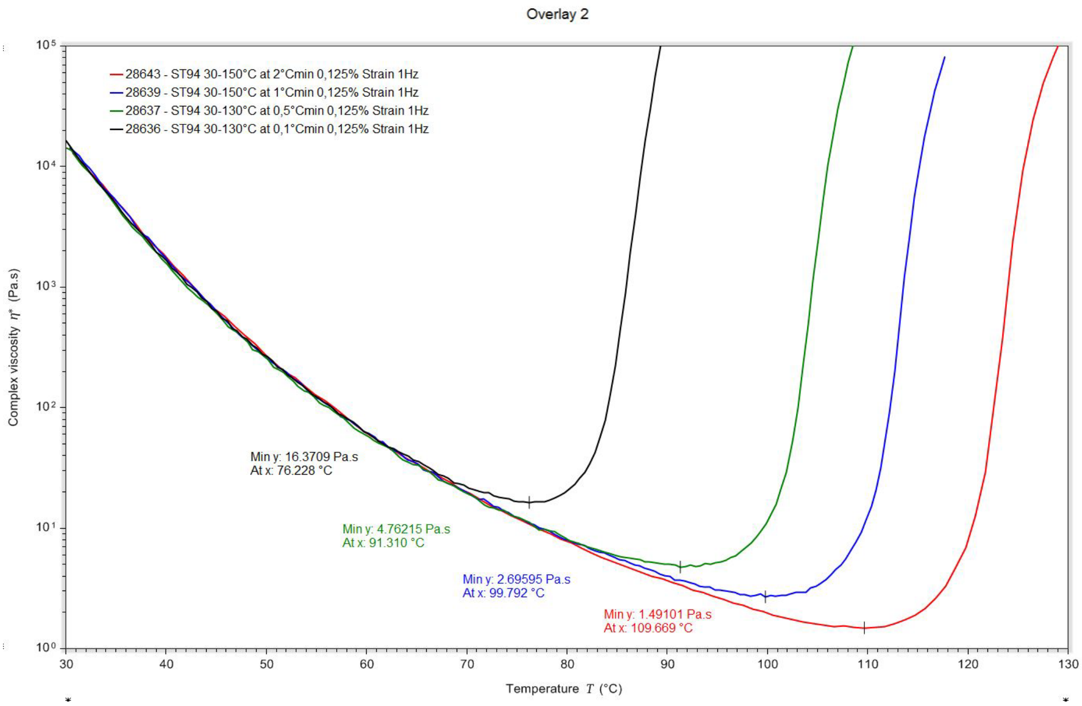

Figure: 9 Minimum viscosity achieved at various ramp rates (ST94)

Achieving ramp rates above 0.3°C/minute in a large oven or with thick cored laminates can be difficult but the resulting higher minimum viscosity will not always create a lower quality laminate. If a slow ramp rate is predicted from thermal mapping of the oven then representative test panels should always be made to ensure required laminate quality.

8.2.3 Intermediate Dwells and Exotherm

- Small parts or thin laminates may be heated at the above suggested ramp rate straight to the final cure temperature as stated in the system Data Sheet.
- Larger more complex parts may be given an initial dwell to allow some degree of temperature equilibration between the oven, tool and various parts of the laminate. This dwell is usually between 55 and 65˚C depending on the size and complexity of the part. Long mid cure dwells should be avoided as these are effectively slowing down the global ramp rate and may therefore prevent optimal minimum viscosity being achieved.
- In the case of very thick monolithic laminates (> 15mm) a secondary dwell may be necessary to burn off exothermic reaction in a controlled manner to prevent high temperatures occurring. The approximate temperature for the relevant system is given in Table 5, at these temperatures the curing reaction is occurring at a fast-enough rate to use up the reactive energy without running out of control. The duration of exotherm dwells needs to be manually controlled by monitoring the laminate temperature and holding until the exotherm peak temperature is past. As laminate thickness, insulation thermal mass of tool, air flow etc. are all variable factors, it is not possible to give a specific time required for any situation.

MATRIX SYSTEM	INITIAL DWELL (STABILISATION DWELL) (°C)	SECONDARY DWELL (EXOTHERM DWELL FOR THICK LAMINATES) (°C)
ST90	55	65
ST94	60-65	75-78
ST95	60-65	75-78

Table: 5 Dwell Temperatures

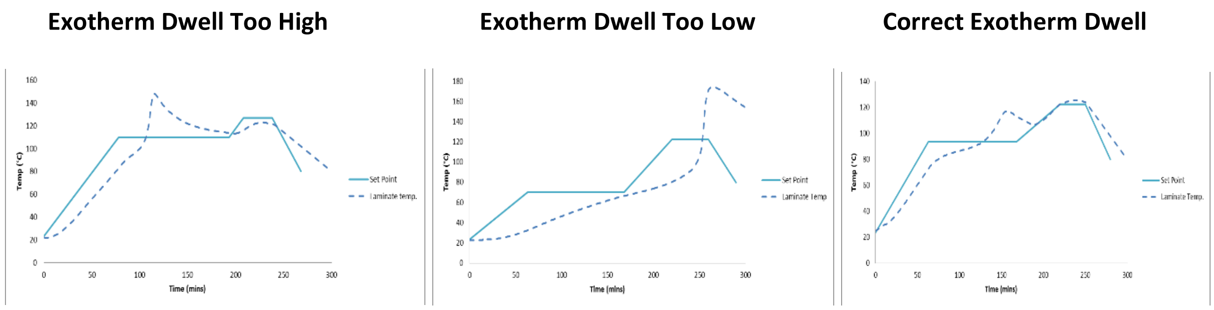

Figure: 10 Example of Effect of Dwell Temperature on Exotherm Potential

8.2.4 Final Cure Temperature

The final cure temperature depends on the resin system, the heating capability and any potential thermal restrictions created by tools.

CURE TEMPERATURE	70°C	80°C	85°C	90°C	100°C
ST90	10 hrs.	4 hrs.	3 hrs.	2.5 hrs.	2 hrs.
ST94	-	-	10 hrs.	7.5 hrs.	5 hrs.
ST95	-	-	10 hrs.	7.5 hrs.	5 hrs.
ST130FR	-	-	6 hrs.	4.5 hrs.	2.5hrs.

Table: 6 Cure Time vs Temperature

- Note curing at higher temperatures will increase the risk of exothermic reaction in the laminate

8.2.5 Full Cure & Glass Transition Temperature

The minimum cure times recommended for each system will equate to >95% of the full crosslinking potential for the given temperature and will provide adequate mechanical and thermal properties. Providing additional cure by means of higher cure temperatures and/or time will only have a marginal effect on mechanical properties but can have a significant positive effect on the thermal resistance of the resin (Glass Transition Temperature (Tg). This can be beneficial for components that are likely to be subjected to high temperatures in service including solar radiation. Higher Tg can help reduce the phenomenon known as 'print through' which is a cosmetic surface defect.

In any event, the Tg of the resin needs to be significantly above the working temperature of the component.

Table 7 demonstrates the higher Tg possible with a 100°C temperature cure.

SYSTEM	MINIMUM CURE	TG (DMA TG1) AT MINIMUM CURE	TG (DMA TG1) AFTER 100°C CURE (3 HRS.)	ULTIMATE TG (THEORETICAL MAXIMUM POSSIBLE TG)
ST90	12 hrs. 70°C	85°C	112°C	115°C
ST94	10 hrs. 85°C	104°C	115°C	120-125°C
ST95	10 hrs. 85°C	104°C	115°C	120-125°C
ST130FR	6hrs at 85°C	100°C	110°C	120-130°C

Table: 7 The effect of elevated cure temperature on resin Tg

Note that achieving the Ultimate Tg is often impractical requiring high post cure temperatures which may be difficult to achieve and may risk part and tool stability.

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8.3 De-moulding

Parts should be allowed to cool naturally under vacuum until <50°C. Maximum cooling rate 5°C/minute

9. TEST PANELS

Gurit strongly recommends that representative test panels are always made before production parts. There are a great many variables and requirements some of which may not be covered in this guide

10. RECORDS

The following records should be kept when building with SPRINT.

PROCESS PARAMETERS
Workshop Temperature
Workshop Relative Humidity
Material Batch numbers and expiry dates
Defrosted time of batches
Layup time/Dates
Vacuum drop test
Vacuum level records during cure
Temperature logs during cure