

SPRINT®

Key Points Summary

1 Description

The dry fibres 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 @ – 18°C.
- Short term <2-4 weeks - De-frosted at room temperature dependent on system.
- 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.
- 100% Vacuum tight – tested prior to use.

6 Surfacing Methods

- Choose method ensuring appropriate option; observe over coating window if appropriate.

7 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.

8 Curing

- 100% Vacuum level (or as close to as possible).
- Ensure even heating rate and correct dwell/cure temperature and time.
- Careful de-moulding once cooled below 50°C.

9 Records

- Careful QC record keeping of material and process parameters.

1. Description

SPRINT[®] materials consist of a layer of fibre reinforcement either side of a pre-cast, pre-catalysed resin film. The material therefore has the appearance of dry reinforcement which has resin concealed at its centre. SPRINT[®] materials are produced by a process that differs from conventional pre-preg; the fibres in the reinforcements remain dry and largely un-impregnated by the resin before use. A tack film is applied to one side to aid positioning.

Single Sided SPRINT[®] comprise a single layer of reinforcement with resin film on one side.

The dry fibres 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.

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.

2. Storage

2.1 Long Term

All SPRINT[®] products should remain Frozen at $<-18^{\circ}\text{C}$ in order to achieve the full 24 month **shelf life** as quoted for the product. SPRINT[®] should be stored, wrapped in plastic in the SPRINT[®] box or stillage provided such that the material is supported by the roll-end cradle in the box.

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' is the best option. Standing rolls on end will allow '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

Like all Prepreg resin systems the material will start to age when de-frosted and at room temperature, with Sprint there is the additional factor of fibre wet-out which starts to occur at room temperature. Despite being formulated to have good cold-flow resistance, eventually the resin will impregnate the fibre restricting the air breathing ability of the Sprint.

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

Full SPRINT[®] rolls can be very heavy and may need mechanical handling as necessary.

PPE should always be worn when handling SPRINT[®] products. Material Safety Data Sheets (MDS's) are available from Gurit Technical Support. Please read these carefully before using SPRINT[®] products for the first time and adhere to the advice given.

3.2 Defrosting

SPRINT[®] products need to be completely defrosted before use. The plastic cover should remain in place until fully defrosted to prevent condensation of moisture onto the material. Defrosting of rolls will normally be complete after an overnight thaw in workshop conditions however, condensation will occur if the material is below the DEWPOINT for the atmospheric conditions as described in Table 1 below.

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

It is best to defrost the roll whilst still supported in the SPRINT[®] Box provided to keep weight off the material. If condensation has affected the Sprint it will often be visible as wrinkling in the paper backer.

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 mould.

As with cutting any product with dry glass or carbon fibres 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 fibres, 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 General

SPRINT[®] is generally cut to size & shape on a cutting table before fitting, this should be kept clean at all times to prevent any possible contamination. Cut parts are best kept flat or rolled on large diameter cores to prevent creasing.

5. Tooling

5.1 Materials

The tool should be constructed of materials that will retain their dimensional stability over the intended processing conditions. Consider the intended 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 i.e. 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.

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. Mould porosity should be checked before any parts are made; any porosity can then 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 SPRINT[®], 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 release surface and generally pinhole free surface. PTFE film is slightly porous to air so vacuum bags should be sealed outside of the PTFE film.

5.4 Tool testing

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 90% (approx. 900 mbar) and 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	Weights	Colour	Comment	Use With
SF70	150g	Light green	Toughened, Paintable	ST70 (70°C Cure)
SF80	150g	Light green	Toughened, Paintable	ST 95, ST94 (ST70 cure at 85°)
SF80FR OBL	100g	Black	Opaque black fire-retardant film	ST95, ST94 (ST70 cure at 85°)
SF96	300g	Dark Grey	Stable, Sandable, Ideal for post painting. Pinhole free	ST95, ST94 (ST70 cure at 85°)
SF95 VH	300g.	Dark Grey	Abrasion resistant	ST 95 ST94 (ST70 cure at 85°)

Table: 2 Surface Films

6.2 Process Coat

There are two process coat options from Gurit, both are designed to provide a pinhole free easy to sand surface for subsequent painting operations. CR3400 is a highly filled and opaque two component 'gelcoat' that is applied into the mould by roller or brush, Sprint Process Coat is a semi-transparent in mould coating designed for large surfaces and machine mixing.

7. SPRINT® Product Application

The key parameters for successful SPRINT® use are;

- 1) Vacuum Integrity and level from the mould and vacuum system
- 2) Good air paths from the SPRINT® to the vacuum stack
- 3) Good and even control of heating to all parts of the mould and component
- 4) Neat and accurate layup of the material avoiding bridging and creasing

7.1 Surfacing Film

The surface films are lightweight breathable Single Sided SPRINT® products and have a partially impregnated fine reinforcement layer; they rely on the dry fabric layer on the outside of the surface film to breathe and provide a smooth defect free surface. Surfacing films are generally applied resin film side to the tool face. Ideally this face is applied to the tool and the backer removed from underneath. It is very important to ensure that the backer is completely removed from 'under' the film as it is smoothed into position. Use a wide soft brush or rubber squeegee to smooth out any air bubbles trapped underneath. Many users like to use a vacuum de-bulking process to ensure good mould adhesion and air removal from the surface film. This is especially useful if heavy reinforcements are to be used on vertical or over-hang surfaces.

The Surfacing Films can be used with the 'dry side' against the tool surface, this allows better breathing on the surface but may compromise the products adhesion to the surface.

Overlaps should be kept as small as possible; butt joints are preferable, if practical, to ensure complete gap-free coverage.



Figure: 1 SF80 Surface Film Application.

7.2 In Mould Processing Coats

CR3400 or SPRINT® Process coat are two component products mixed and applied direct to the mould. Please refer to the more detailed Gurit 'In-Mould Coatings Processing Notes' for application.

7.3 SPRINT® layup

Whether full length of pre-cut pieces, the application of SPRINT® is straight forward.

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. The product only needs gentle firming into position. Tight radii and corners may have to be cut-in, to allow the material to conform. Overlaps should be kept neat and small approx. 30-50mm.

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.

SPRINT® does not normally need to be de-bulked between layers, it can be used to produce thick laminates quickly and easily. However some high thickness complex mouldings may benefit from one or more de-bulks in order to de-loft and make lay-up easier. This needs to be a few moments only in order to consolidate the material without encouraging wet out.

7.4 De-lofting

Sprint users need to 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 can result in excess material ('ears') forming over male contours or bridging in female contours. (See Figure; 2 and 3 below) This is one area where a quick de-bulk may be beneficial to reduce the thickness differential between the uncured and cured laminate. Alternatively Sprint can be cut into radiuses and overlapped creating a slip joint. Internal corners should be cut-in to prevent bridging, heavy consolidation into corners might make the material conform but may risk locking off air paths. It's much easier to cut and overlap and allow the materials to slip slightly during the impregnation and de-loft stage. In extreme situations it might be necessary to use multiple cures or prepreg.

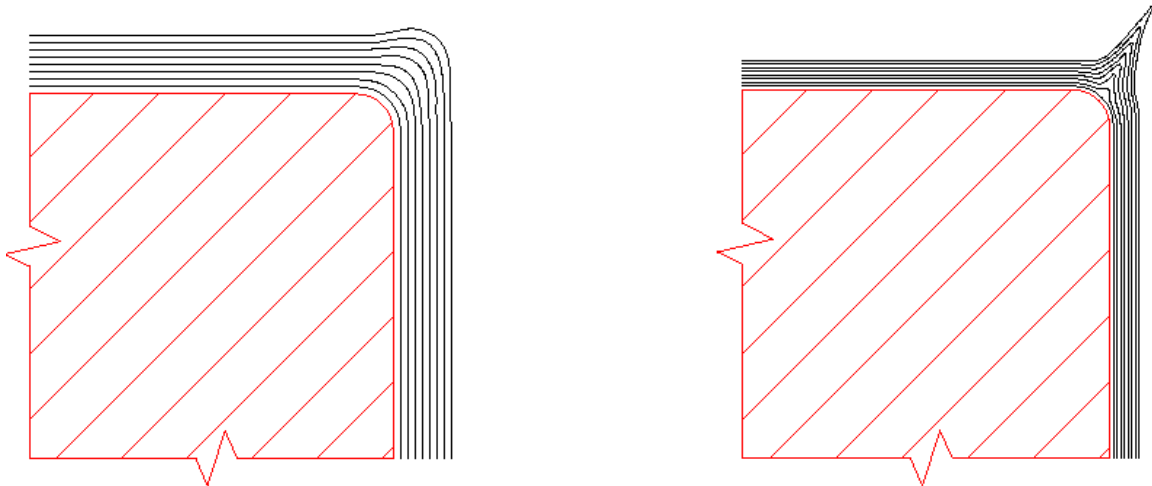


Figure: 2 Potential 'ears' caused by de-lofting on outside corners

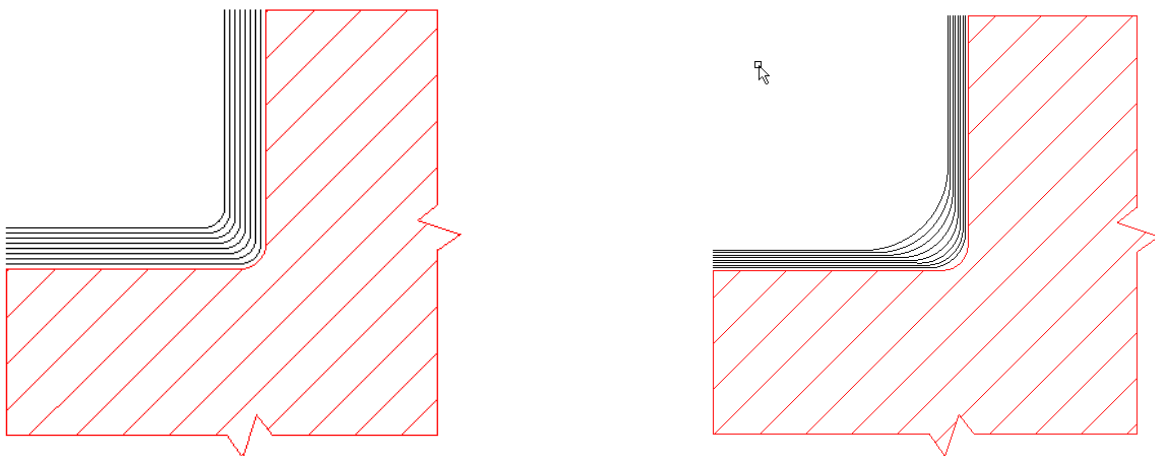


Figure: 3 Potential bridging caused by de-lofting on inside corners

7.5 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 such that the edge of each ply is in connection with the vacuum stack.

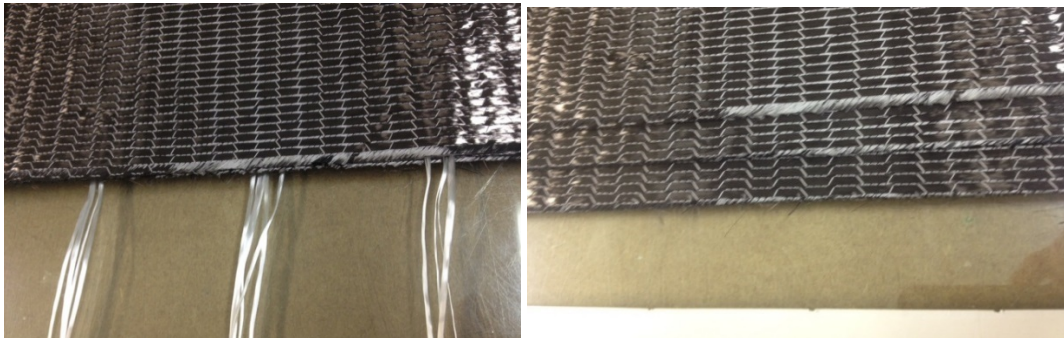


Figure: 4 Glass tows between plies to aid breathing and staggered edge method

Avoid any situation where plies are isolated from the vacuum especially in thicker sections of single sided product where 'buried' plies may not have good access to edge or breather tow air paths.

7.6 Vacuum Consumables

Once the component is laid up, the vacuum consumables and bag are fitted. In most cases this will be;

- 1) Peel Ply – Scoured Nylon Stitch Ply A, 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

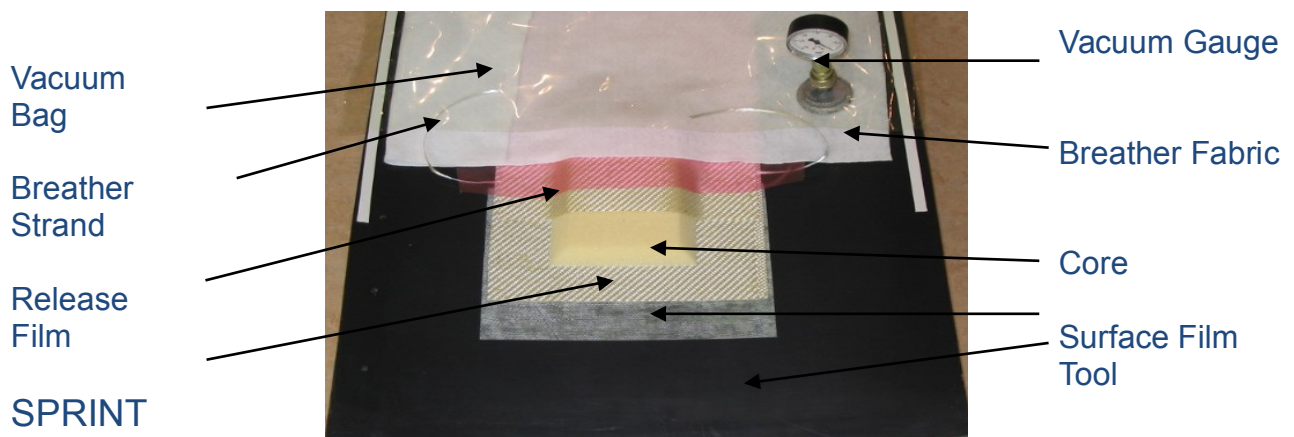


Figure: 5 General Lay-up Materials

Very large components for (example >5mx5m) should provide additional air flow medium such as infusion mesh because the breather fabric can crush and lower vacuum levels and consolidation to the middle of parts.

Use high quality vacuum bags designed for composite use with a thermal requirement well in excess of the desired cure temperature with allowance for exotherm. 200°C capability is most preferred with these systems

7.7 Cores, selection and use

A variety of cores are suitable for use with SPRINT[®], Corecell is the favourite foam core as it can handle the normal processing temperatures, has low resin absorbency and does not out-gas. Always use PH (pin hole perforated) core to allow air/resin flow, or, if required, Double Cut to provide some flexibility.

Core	Maximum Processing Temperature(°C)	Suitability for co-curing
Corecell M	120	Yes
Gurit PVC HT	120	Possible outgassing - make test panels
PET	130	Yes
Balsa	120	No unless extremely dry
Other PVC	Depends on grade	Possible outgassing - make test panels
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 be more absorbent 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 SA70 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.

7.7.1 Three Hit Processing

If making cored parts in a three hit sequence, the first skin is laid up and cured initially. Next, the peel ply from the first skin is removed and the core is bonded under vacuum and finally the second skin is laid up and cured as an independent step. This is generally low risk but more time and energy consuming.

7.7.2 Two Hit Processing

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

7.7.3 One Hit processing

Here the first skin, the core and second skin are all laid up consolidated and cured under one bag in one operation. It requires very accurate core placement/kitting and carries the highest risk. Often is only carried out on small simple or flat panels.

7.7.4 Core bonding

There are three possibilities for bonding the core.

- 1) In a three hit process the core could be bonded with a proprietary wet core bonding system such as SP368.
- 2) More usually, SPRINT[®] laminates are bonded to the core layers with Adhesive Film such as SA70 or SA80. These are filled & toughened resin films with controlled flow characteristics. 250 to 400g/m² adhesive film is generally used for core bonding applications. This is simply laid up onto the core or laminate at the interface. 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 need to be spiked to allow gas to escape.

- 3) The third option is to use excess resin in the SPRINT® to bond the core. For this application, high resin content SPRINT® products can be produced.

Certain SPRINT® materials can be ordered with additional resin content to take care of core bonding operations. Eg. Normal Glass SPRINT® resin content = 40%

Core bonding Glass SPRINT® resin content = 50%

Often a combination of Adhesive film and high resin content SPRINT® is used for convenience.

7.7.5 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. In one-hit cure operations it is imperative that not only is sufficient resin and or glue film provided, BUT THAT cure profiles are sufficient to allow good resin flow, this means avoiding very slow ramp rates see below.

With cut core, the radius of the mould has a huge impact on the resin requirements, additionally, the ability of the resin to flow is affected by the cure profile, thick foam core will often insulate and reduce the ability to get heat and therefore flow into the part. If double thickness cores 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 are achieved.

The ideal core for curved parts is thermoformed PH M foam, this will be the lightest and toughest solution.

7.7.6 Mono-component Pastes and Core Splice

For 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 6 SP4832 Monocomponent paste being used.

7.8 Unidirectional Materials

SPRINT cannot be made with unidirectional reinforcements because the UD fibres allow such minimal air paths. However SPRINT® can be laid up and co-cured with conventional UD pre-pregs with similar curing requirements e.g. ST 95 SPRINT® with SE84 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 lay those up in one go.

Contact Gurit Technical Support for more details.

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

Once the whole panel is laid up with the breather tows and vacuum consumables; the bag is fitted allowing pleats so no that bridging occurs around mould features. Vacuum should be applied and levels checked as described in Tooling section above.

Once vacuum is applied it should not be disconnected until after the curing process.

8.3 Cure Cycle

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

All temperatures discussed below refer to laminate temperatures not oven temperatures

Important points;

- Ramp rate
- Intermediate dwell temperature (Infusion dwell/ exotherm dwell)
- Cure temperature
- Cure time

8.3.1 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.

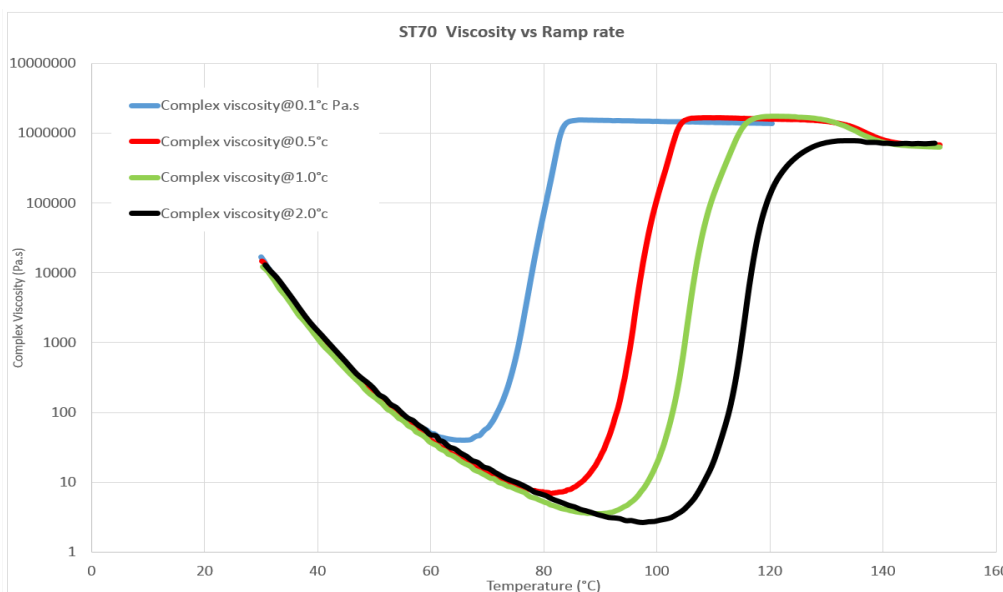


Figure: 7 Minimum viscosity achieved at various ramp rates

8.3.2 Dwells

- 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 and should be held for between 1 & 3 hours depending on the size and complexity of the part. Very 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 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 4, 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)	Thickness where exotherm dwell should be considered
ST70	55	65	12
ST94	60-65	75-78	15
ST95	60-65	75-78	15
ST160	70	Contact Tech. Support	

Table: 5 Dwell Temperatures

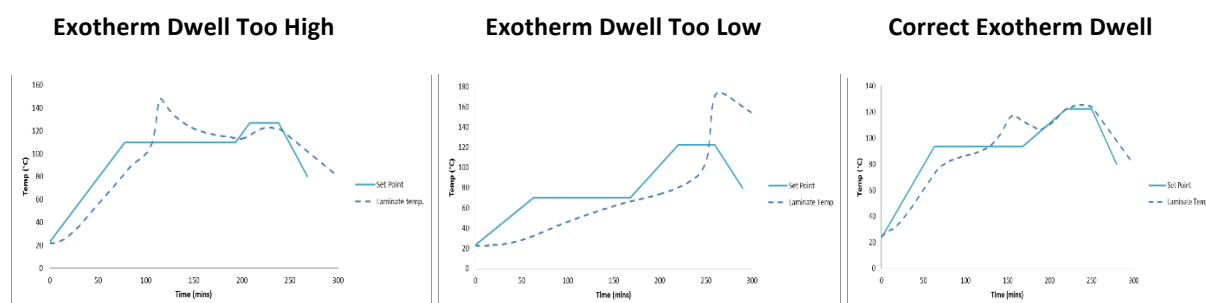


Figure: 8 Example of Effect of Dwell Temperature on Exotherm Potential

8.3.3 Final Cure Temperature

Cure Temperature	70°C	80°C	85°C	90°C	100°C	160
ST70	16 hrs.	8 hrs.	6 hrs.	4 hrs.	2 hrs.	
ST94	-	-	10 hrs.	7.5 hrs.	5 hrs.	
ST95	-	-	10 hrs.	7.5 hrs.	5 hrs.	
ST160	-	-	-	-	-	30 minutes

Table: 6 Cure Time vs Temperature

ST160 is designed for rapid cure processing of production parts, this will often be press moulded applications which is beyond the scope of this document.

The cure time of all Sprint products can be reduced using the following guide.

For every 10°C increase in the Cure Temperature the Cure Time is halved.

E.g. for ST70 products 16 hrs. 70°C or 8 hours 80°C 4 hours 90°C and so on

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

8.3.4 Full Cure & Glass Transition Temperature

The minimum cure times recommended for each system above 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 temperature including solar radiation which can cause a phenomenon known as 'print through' - a cosmetic surface defect.

System	Minimum Cure	Tg (DMA Tg1) At minimum cure	Tg (DMA Tg1) After 100°C cure (3 hrs.)	Ultimate Tg (Theoretical maximum possible Tg)
ST70	16 hrs. 70°C	85°C	108°C	120°C
ST94	10 hrs. 85°C	104°C	115°C	125°C
ST95	10 hrs. 85°C	104°C	115°C	125°C
ST160	30 mins. 160°C	155°C	N/A	160°C

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

8.4 De-moulding

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

9. 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
Keep product backers and count to ensure none missing or damaged
Vacuum drop test

Vacuum level records during cure
Temperature logs during cure

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