BHOR Preg

Prepreg Systems

Storage, Handling and Processing Method Statement for: BhorPreg® Prepreg Systems

BhorPreg® Prepreg Systems are advanced hotmelt epoxy prepregs developed to enable manufacturing of various high performance Aerospace, Automotive Sports and Industrial composite applications.

BhorPreg® Prepreg Systems have been specially formulated to achieve excellent through-cure and mechanical performance, have a versatile curing cycle and they can be combined with Glass, Carbon as well as Aramid in a wide variety of reinforcements such as Unidirectional Tapes, Bidirectional Woven Fabric reinforcements in Plain, Twill and Satin Weaves.

BhorPreg® Prepreg Systems are suitable for Autoclave as well as Out of Autoclave processing and can produce a wide range of composites from small components to large structures of excellent quality with low void content.

Advantages

- Excellent surface finish.
- Wide choice of application processes (Out of Autoclave vacuum bagging, autoclave layup, etc.)
- Suitable for wide range of curing temperatures.
- Easy to handle and process.
- Suitable for a wide range of applications such as aerospace, sports, marine & automotive.
- Excellent mechanical properties in product

Prepreg Systems

System	Description
BhorPreg® A45	Standard prepreg resin system for Sports and Industrial applications
BhorPreg® A22 / A108 / A111	Fast cure prepreg systems to enable economic manufacturing of various automotive and sports applications.
BhorPreg® A109 /A110	Toughened Epoxy Prepreg System for aerospace, sports and automotive applications
BhorPreg® M15	High Tg Epoxy Prepreg for Aerospace and Industrial applications
BhorPreg® A117B	Tooling Prepreg System

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Reinforcements

BhorPreg® Prepreg systems can be combined with Carbon, Glass and Aramid fibres in a wide range of Pure Unidirectional and Woven Bidirectional Reinforcements with different weave patterns and Fibre Aerial Weights to suit specific application and process requirements. Users are advised to contact Bhor Technical staff to customize prepreg specifications.

Reinforcement	Carbon Fibre				Glass Fibre		Aramid Fibre	
	Unidirectional Carbon		Bidirectional Carbon		Unidirectional Glass	Bidirectional Glass	Bidirectional Aramid	
Fibre Aerial Weight (gsm)	160 – 200		100 – 650		200 – 300	200 – 560	170 – 480	
Width (mm)*	500		1000		500	1000	1000	
Weave	UD		Plain, Twill, Satin		UD	Plain, Twill, Satin	Plain, Twill, Satin	
Resin Content (%)	33 - 42		33 – 50		33 - 42	33 - 50	33 - 50	
Fibre Properties								
Density (g/cm^3)	1.8	1.81	1.8	1.81	2.52	2.52	1.44	
Filament Diameter (µm)	7	5.1	7	5.1	13	13	12	12
Tensile Strength (MPa)	4000	5690	4000	5690	3750	3750	3176	2944
Tensile Modulus (GPa)	240	290	240	290	80	80	108	102
Elongation (%)	1.7	2	1.7	2	4.8	4.8	2.8	2.9

**Custom widths available on request*

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Prepreg Systems

Adhesive Films for bonding Sandwich Core Materials

To aid easy adhesion of Sandwich Core Materials, compatible Adhesive Films can be supplied which can be co-cured with BhorPreg® Prepreg skin plies. Please refer to **BhorFilm®** technical data sheets for details.

Transportation, Unpacking, Storage, Shelf Life, Handling, Lay-up, Curing

Prepreg materials are sensitive to environmental conditions, handling and cure variables, hence care needs to be taken to adhere to standard operating practices, failing which structurally unsafe components may be produced. At best, costly rework operations would be involved; at worst, the component may have to be scrapped. It is important that the applicable specifications and/or manufacturer's detail requirements and recommendations for shelf life, storage temperature, and handling instructions be followed.

All personnel concerned with procurements, handling, storage, and usage should be keenly aware of the critical nature of the design function of these items and be alert to potentially unsatisfactory conditions regarding storage temperatures, storage life, and storage conditions. This is particularly true for manufacturing and inspection personnel.

1. Transportation

It is recommended to transport BhorPreg® Prepregs in controlled conditions, ideally at -18°C in refrigerated carriers. When refrigerated transport is not viable, BhorPreg® Prepregs are packed with adequate insulating material along with dry ice packs to maintain a low temperature inside the prepreg packaging. Owing to limited out life of dry ice it is important to opt for fastest possible mode of transport.

Temperature data recorders are available on request to maintain a log of the temperature of the prepreg during transit.

During transit and storage it is important to maintain the prepreg in horizontal position to avoid slippage of wound prepreg coils and damage to prepreg. Care must be taken to avoid puncture to packaging materials to protect from humidity and exposure to higher temperature.

2. Unpacking

BhorPreg® Prepregs are vacuum sealed in polyethylene bags and packed in corrugated cartons along with dry ice packs to maintain a low temperature inside the prepreg packaging, polystyrene foam sheets are also added for insulation and cushioning. Prepreg rolls are supported with flange supports on both ends.

During unpacking care must be taken to prevent puncturing of the polyethylene bags. Prepreg rolls must be lifted out of the box taking support of the core tube from both ends,

Prepreg coils must not be touched. Flange supports must be maintained on both sides to prevent the prepreg from touching the floor directly. Prepreg roll should not be removed from the polyethylene bags.

Where requested, temperature data recorders should be stopped on opening of the prepreg box.

Packaging materials may be disposed as per local guidelines.

Prepreg in packaging

3. Storage

BhorPreg® Prepregs should be stored as received, at -18°C in deep freezers, in sealed condition. Put one more sealed moisture-proof bag if necessary.

Avoid storage in unsealed/open condition when not in use.

Flange supports must be maintained on both sides to prevent the prepreg from touching the floor directly.

It is important to maintain the prepreg in horizontal position to avoid slippage of wound prepreg coils and damage to prepreg.

Prepreg storage in deep freezer

4. Shelf Life* and Out Life**

Sr. No.	Prepreg System	Out Life	Shelf Life (at -18 °C)
1	A45	30 Days At 22°C	One Year from date of mfg.
2	A22	30 Days At 22°C	One Year from date of mfg.
3	A100	30 Days At 22°C	One Year from date of mfg.
4	A109	30 Days At 22°C	One Year from date of mfg.
5	A116	30 Days at 22°C	One Year from date of mfg.
6	A117B	20 Days at 22°C	One Year from date of mfg.
7	M15	30 Days At 22°C	One Year from date of mfg.

**Shelf life will differ for each prepreg system, users are advised to refer to individual prepreg data sheets.*
***Out life will differ for each prepreg system, users are advised to refer to individual prepreg data sheets.*

5. Thawing / Defrosting

Before using the prepreg material, it should be allowed to reach room temperature after removal from deep freezer. It should be taken out from Deep Freezer in its air tight packaging and thawed in moisture-proof packaging (i.e. PE bag) to avoid condensation. Thawing may take 6-12 hours depending on the roll size. Before removing the prepreg from the polyethylene bags condensate on the bags should be wiped-off gently using an absorbent cloth.

It is important to maintain the prepreg in horizontal position to avoid slippage of wound prepreg coils and damage to prepreg.

It is recommended to thaw the Prepreg materials at 22^0C - 25^0C.

Unused prepreg material must be immediately returned to the deep freezer while being properly packed in moisture proof bags.

When materials are removed from the cold storage environment, it is recommended to maintain a log that would indicate the number of hours that the materials are out at room temperature during fabrication.

6. Lay-Up Area & Environmental Controls

The Prepreg layup should be performed in a clean dust free area. Work surfaces should be free from dust, debris or oils. Materials should be cut on a clean stable surface that is not likely to introduce any potential contaminants in the final lay-up. Typical surfaces are a glass sheet, polypropylene, nylon, or rubber.

It is recommended to maintain working environment temperature at 23±2°C and Relative Humidity should be 50 ± 5%.

7. Safety Precautions

Precautions should be taken while handling, use of personal protective equipments (e.g. gloves, masks) is recommended, also ensure arms are covered, thus avoiding skin and eye contact while application.

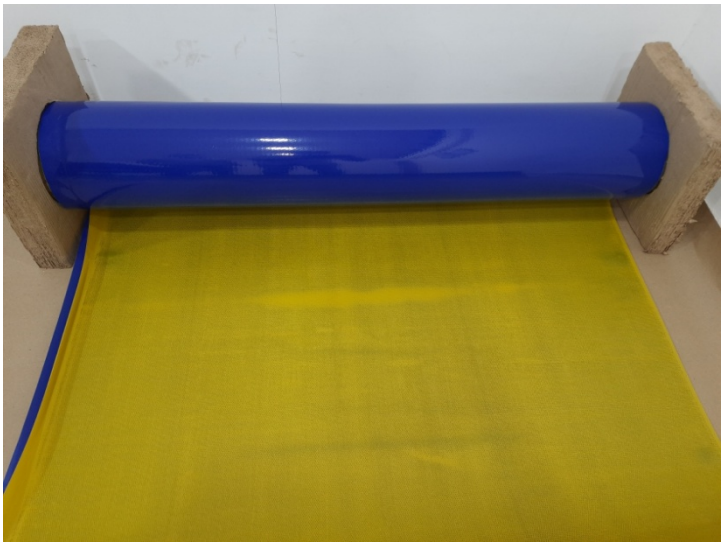
While handling BhorPreg® Prepregs, use of following PPEs are recommended:
1. Face masks to prevent suffocation or inhalation of hazardous particles.
2. Hair Nets to protect head and hair, also to avoid FOD (foreign object debris).
3. Hand gloves for protection of hands (Nitrile gloves are recommended).
4. Safety goggles for eye protection.

8. Handling

8.1. Unrolling and Cutting

Before removing the prepreg from the polyethylene bags, any condensate appearing on the bags should be wiped-off gently using an absorbent cloth. Polyethylene bags can be folded and kept aside for reuse.

It is important to maintain the prepreg roll in horizontal position to avoid slippage of wound prepreg coils and damage to prepreg. Flange supports must be maintained on both sides to prevent the prepreg from touching the floor directly, flange supports also aid unwinding of the prepreg rolls while unrolling from the bottom of the roll. Prepreg must be unrolled on a flat table to avoid creasing.



Unwinding of Prepreg roll

After the required length of prepreg roll has been cut, the open end of the prepreg roll must be immediately closed using a pressure sensitive adhesive tape. This will not only prevent the remaining prepreg roll from unwinding but will also help to maintain a tightly wound prepreg roll to avoid creases in the prepreg. Prepreg must then be packed in polyethylene bags, sealed and returned to cold storage without delay.

BhorPreg® Prepregs are covered by protective coverings on both sides which are not to be removed until assembly lay-up. Prepreg should be cut to shape before removing the protective coverings. Prepreg can be cut by hand held shears or blades, automatic ply cutting machines and also by die stamping. When using hand held cutting blades, adequate pressure must be applied to cut through the top protective ply, prepreg and bottom protective ply in one attempt to avoid distorting the weave of the reinforcement fabric in the prepreg. Sharp blades must be maintained to avoid distortion of prepreg while cutting. Cut prepreg plies must be properly labeled to ensure they are positioned as per the lay-up sequence.

8.2. Mould preparation

It is essential to consider the correct regime for application of mould release systems. Various mould release films and liquid application systems are available; please follow individual manufacturer's instructions for application. Compatibility of release system for the type of mould, matrix and curing cycle is critical.

Use of **BhorBond® Release G** system is recommended; please follow respective literature for detailed application procedure. BhorBond® Release G system allows multiple molding cycles with single application of the release system.

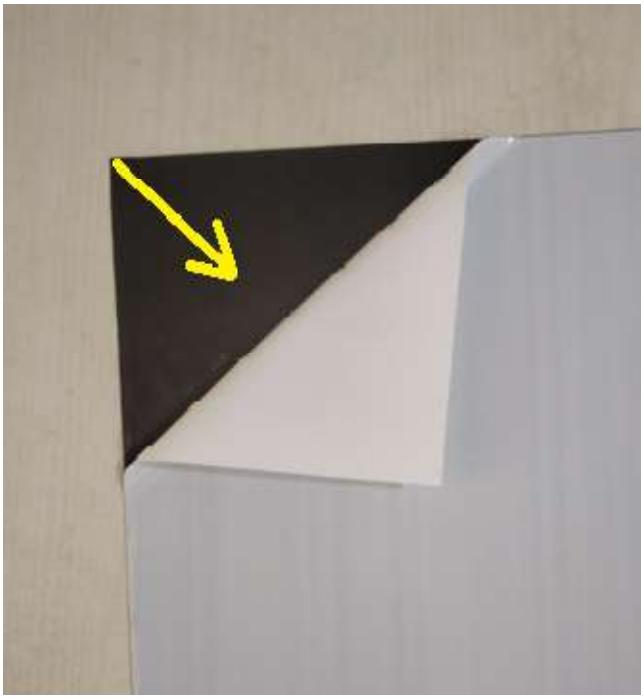
Alternatively, **BhorFilm® Tool Release** can be employed for mold preparation, for the better release performance and excellent surface finish of cured prepreg parts. Please refer to relevant data sheets for details.

Mould temperature during layup is an issue that warrants consideration because of differential thermal expansion between tool and the prepreg. It is recommended to maintain the mould at constant temperature at the time of prepreg lay-up, cooling of mould temperature could result in ply wrinkling. At worst, the tool should be gradually warming if not maintained at constant temperature

8.3. Lay-up

For removing the protective plies on the prepreg during lay-up, place the cut prepreg flat on the molding station, a sharp knife or blade can be used to gently lift a corner of the protective ply and the protective ply can then be held between fingers and pulled off.

For unidirectional prepregs it is recommended to pull of the protective ply at angle of about 45^0 to the orientation of the prepreg, this helps to avoid pulling of UD prepreg strands while removing the protective plies.



Removing Protective Covers from UD Prepreg

It is recommended to remove the protective ply on one side followed by positioning and placing the prepreg in the mould, flattening using a roller and then removing the second protective ply.

During lay-up, place the prepreg into position with an "up-down" motion only. Maintain sufficient tension as it is laid in place to keep the fibres straight to avoid distortion, waves or bubbles in the ply. Press the ply in place only lightly initially, and check to ensure that it is in the correct position; if not, lift the ply directly upward from the underlying surface with a peeling motion and re-lay it. Do not try to shift a misplaced ply sideways without lifting it up as the tackiness of the prepregs will cause it to distort and also disturb already laid in plies. Once correctly located, the prepreg can be pressed, compacted or rolled firmly (when the top carrier is still in place, it will not move).

To aid easy removal of protective plies use of **BhorBond® Coolant Spray** is recommended.

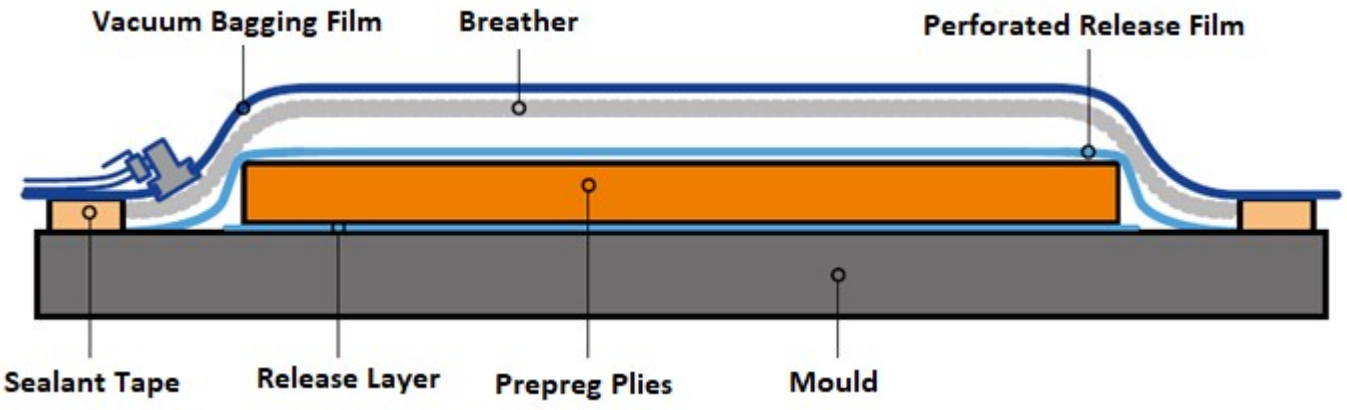
Protective films may be disposed as per local guidelines.

8.4. Debulking

It is essential to debulk the prepreg for up 30 minutes, at least at the stages stated below:

- After ply 1
- Every subsequent 3 plies
- After the final ply has been completed

This will ensure even consolidation and remove air from the laminate prior to final curing. More complex shapes can sometimes be easier to laminate if more frequent debulks are used. If a laminate will take more than one day to lay-up, then it must be debulked overnight to ensure that it stays in place.



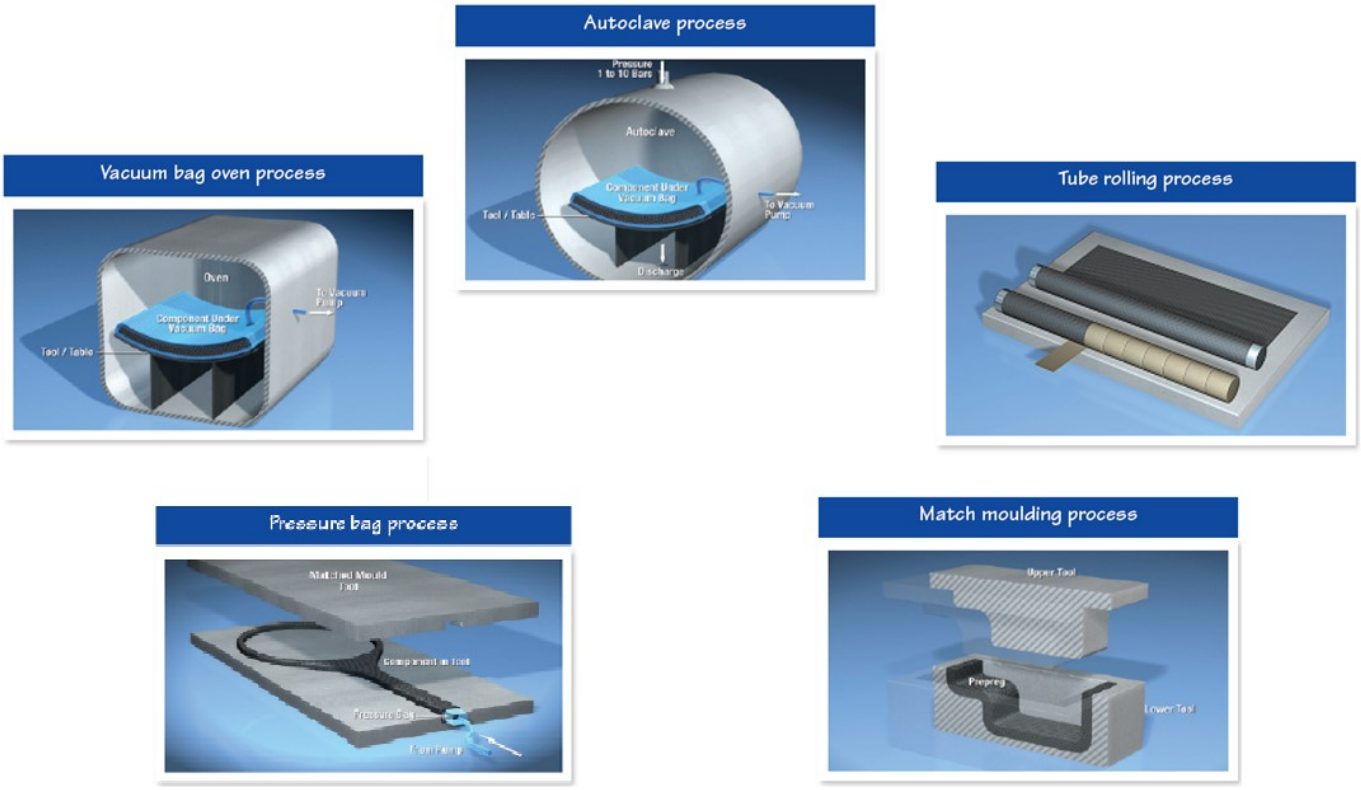
Debulking

8.4.1. Debulking procedure:

- Cover entire laminate surface with a perforated release film, extending beyond the lay-up by approximately 25 mm (1 inch).
- Apply a breather coat in total to the surface. Tailor to fit to avoid bridging.
- Cover the laminate/assembly with a vacuum bag, ensuring that enough slack has been provided to pull into all corners without any bridging.
- Apply full vacuum and leave for 30 minutes.
- When removing materials from the surface afterward, be careful not to lift up the previously laminated plies.

8.5. Processing Methodology

Prepregs can be processed in different ways. The drawings below demonstrate the most appropriate method to be chosen for a particular application. For large parts heated tools may be more appropriate than an oven.



Prepreg Processing Techniques

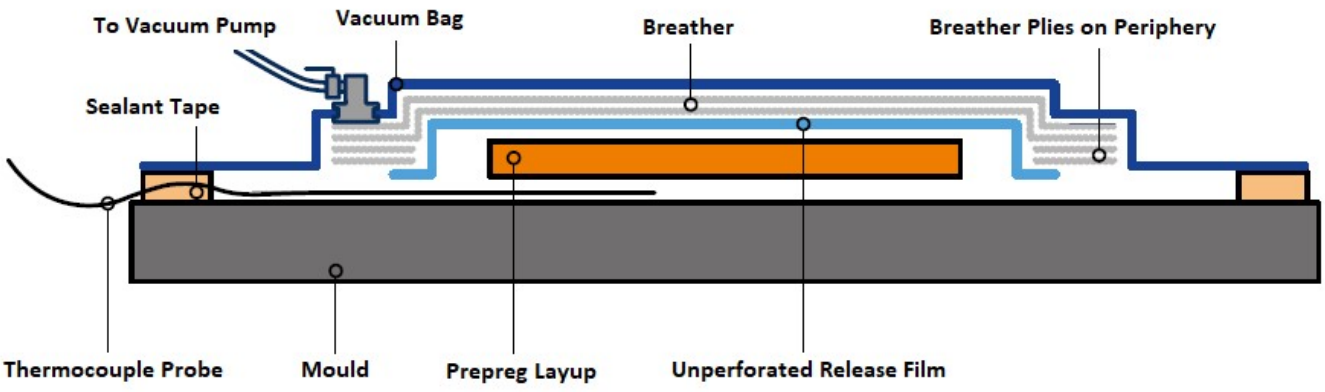
Vacuum bag/oven and autoclave processing are the two main methods for the manufacture of components from prepreg. The processing method is determined by the quality, cost and type of component being manufactured.

Vacuum bag processing is suited to monolithic components of varying thickness and large sandwich structures. The vacuum bag technique involves the placing and sealing of a flexible bag over a composite lay-up and evacuating all the air from under the bag.

The removal of air forces the bag down onto the lay-up with a consolidation pressure of up to 1 atmosphere (1 bar). The completed assembly, with vacuum still applied, is placed inside an oven or on a heated mould with good air circulation, and the composite is produced after a relatively short cure cycle.

Autoclave processing is used for the manufacture of superior quality structural components containing high fibre volume and low void contents. The autoclave technique requires a similar vacuum bag but the oven is replaced by an autoclave. The autoclave is a pressure vessel which provides the curing conditions for the composite where the application of vacuum, pressure, heat up rate and cure temperature are controlled. High processing pressures allow the moulding of thicker sections of complex shapes. Honeycomb sandwich structures can also be made to a high standard, typically at lower pressures. Long cure cycles are required because the large autoclave mass takes a long time to heat up and cool down. Sometimes slow heat up rates are required to guarantee even temperature distribution on the tooling and composite components.

8.6. Preparation for Autoclave / Out of Autoclave Curing



Preparation for Autoclave / Out of Autoclave Curing

8.6.1. Fit a thermocouple underneath the first ply of the material on an area that is not a critical mold surface.
8.6.2. Cover entire laminate with a non-perforated release film, extending the edges by around 25 mm (1 inch).
8.6.3. Apply one or 2 plies of breather coat. Tailor to fit and ensure all areas are interlinked. Fit an extra 2 plies around the periphery between the edge of the laminate and the inside of the vacuum seal.
8.6.4. Cover with a vacuum bag, ensuring that enough slack has been provided to pull into all corners without bridging. At this stage, the vacuum pack will appear very bulky; care must be taken to ensure all materials remain in position as the vacuum bag pulls down.
8.6.5. Apply full vacuum pressure and leave for 30 minutes prior to autoclave / out of autoclave processing. Check for vacuum integrity and position of tucks in the bag.

8.7. Curing Cycle

Reference Cure and Post Cure Cycles are provided for all BhorPreg® Prepregs, please refer individual prepreg data sheets.

The matrix viscosity, flow, reaction rates and component surface quality are all affected by the chosen heat up rates and intermediate dwell temperatures. BhorPreg® Prepregs can be processed by a range of heat up rates. Generally, fast heating rates are possible for thin components and slow heating rates are used for large and thick components. The heat up rate selected should avoid large temperature differentials between the component, tool and the heat source.

In certain circumstances, such as the production of thick section laminates and large components, rapid heat-up rates can undergo exothermic heating leading to rapid temperature rise. Where this is likely, a cure incorporating an intermediate dwell is recommended in order to minimize the risk. It will aid even temperature distribution throughout the tooling and component. Good temperature control will provide consistent and improved resin flow characteristics during cure.

8.7.1. Temperature tolerances

The oven/autoclave, component and tooling, should all reach and remain at the required temperature throughout the cure cycle. Thermocouples used to monitor the temperature should be placed carefully to ensure accurate information is received for the whole system and to operate at the cure temperature ±2°C.

Cooling cycles should be controlled to avoid a sudden temperature drop which may induce high thermal stresses in the component. Pressure and/or vacuum should be maintained throughout the cooling period.

9. Disclaimer

While the information contained herein is true, accurate and represents our best knowledge and experience, no warranty is given or implied with any recommendations made by us or our representatives, as the conditions of use and the competence of any labour involved are beyond our control.

Suggestions made by BHOR technical staff either verbally or in writing, may be followed, modified or rejected by the user, engineer or contractor since they, and not BHOR, are responsible for carrying out procedures appropriate to specific applications.

Technical Data Sheets are updated on regular basis, user must always refer the latest issue of for the relevant products; copies of the same shall be shared upon request.