



## **"Aestetica" Prepregs – Technical Data Sheet**

### Foreword

One of the most recent techniques for making composite components is by using prepreg fibre reinforcement, cured under heat and pressure to produce professional quality parts with a high quality surface finish and low resin content.

"Aestetica" products are new on the market, an uncured fibre is easy to handle and can be cut and laid precisely into the moulds making the process ideal for smaller, complex parts. The ease and accuracy with which the material can be templated and cut means that material can be used very efficiently; significantly reducing waste compared to other manufacturing techniques.

Despite the many advantages to prepreg production and its potential for delivering excellent results on complex mouldings, is necessary to adapt the processes to the new product; especially surface finish is governed by the dry fabric composition: the unicity of the obtainable results are mainly governed by the technology and capability in prepreg processing; tendentially the learning curve of Aestetica prepregs is generally longer than conventional materials.

### "Aestetica" Prepreg

Prepreg is the name given to composite reinforcement materials, that have been pre-impregnated with thermosetting resin.

The most common way to make a composite part from prepreg reinforcement is to layer the uncured prepreg reinforcement into a mould, vacuum bag the mould and laminate and then cure it in an autoclave or an oven.

The special formulation of the epoxy ensures that at ambient temperature the curing process is slow (often several weeks) and that at freezing temperatures (typically -18°C) prepregs can be stored for months without losing the processing properties. The amount of time the resin system can spend at room temperature before noticeable partial curing of the resin takes place is known as the material's 'out life' whilst the time that the prepreg can be stored in the refrigerator and remain useable when thawed-out is known as its 'freezer life' or 'shelf-life'.

At room temperature, prepreg resin systems have such a high viscosity that, even though they are made of uncured resin, they can easily be handled.

The viscosity at room temperature and other properties of a specific resin system determine the level of 'tack' of the prepreg. Tackier prepregs require more delicate handling but will easily stick to mould surfaces, less tacky pre-pregs are easier to handle but may not stick as easily to a mould's surface.

Only at elevated temperatures, known as the cure temperature, does the resin really start to react and cure properly which is why prepregs must always be cured in an oven of some description. Typical cure temperatures for prepregs range from 85°C up to around 140°C with the most common cure temperature for out-of-autoclave prepregs being around 100°C.

### Minimum requirements

It is essential that the oven which will allow to set and maintain a temperature of at least 100°C.; it is also important to refer this temperature to the mould temperature and to have an oven system which avoid air stratification during the process. It is not essential, to have a hole through the side or back of the oven through which a vacuum hose can be passed enabling a vacuum connection to the parts to be maintained during their cure. If this is not an option then it is possible to cure a part without a vacuum connection inside the oven providing that the part has been vacuumed-down outside of the oven and that the vacuum bag is perfectly sealed. It is then also essential that the bag does not develop a leak or lose vacuum pressure during the full curing cycle.

Because the prepregs used in this guide need to be cured at, or around, 100°C, it is essential that the mould the prepreg will be laminated into is able to withstand this temperature without softening, distorting or deteriorating. The resin system used in the prepreg is epoxy and so it is also important that the mould material is compatible with epoxy resin. For these two reasons, standard polyester moulds are not suitable for use in making prepreg carbon fibre parts and should not be used. Instead, moulds can be made from high temperature epoxy, metal (such as aluminium or stainless steel).

To ensure the best possible results from out-of-autoclave prepreg process careful procedures must be observed.

Most prepregs are intended for curing at very high pressure in an autoclave and under these conditions will yield an excellent, pin-hole free, surface finish. Unfortunately however, these same prepregs, when cured under vacuum pressure only in an oven will result in a pin-holed surface finish that many people would find unacceptable. For this reason, purpose developed 'Aestetica' surfacing prepreg is used as the surface ply.

In this example will be used a single layer of the "Aestetica" surfacing prepreg backed up with a double layer of 320-380g/sqm glass roving 300 tex fabric conventional prepreg This will result in a cured laminate thickness of around 0.75-1.25 mm which is an ideal thickness for many none-structural or semi structural parts

Aestetica surfacing prepreg fibre

always backed with 52 g/sqm prepreg

2 layers 320-380g/sqm backing Prepreg glass roving Fibre (this solution is suitable for vacuum bagging, for autoclave and/or press moulding a 560g/sqm 68 tex yarn 5H satin)

Unperforated Release Film

Vacuum Bagging Film

Vacuum Bagging Gum Tape

Vacuum Bagging Breather Cloth

Release Agent (ChemTrend Chemlease suggested);

It is strongly suggested to avoid perforated release film and to provide additional vacuum connectors when the mould shape is complex and or with a dimension that exceed 250x250mm

Note: one option is to use as first layer (tool side) before "Aestetica" Prepreg one layer of 25-50g/sqm glass fabric, this option reduces pit holes and give increased matt finish as FAW increases.

Step by Step Guide

1. Mould Preparation

2. Creating Cutting Templates

3. Cut Prepreg Material
4. Putting Down the Surfacing Ply
5. Adding the Backing Ply/Plies
6. Release Film
7. Breather Cloth
8. Make the Vacuum Bag
9. Loading the Parts and Positioning the Through-Bag Connector
10. Complete the Vacuum Bag
11. Vacuum Bag Pull-down
12. Vacuum Leak Drop-Test
13. Loading into the Oven for Curing
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### 1. Mould Preparation

Mould preparation for prepreg laminating is much the same as for other processes. Because curing will take place at around 100°C it is very important to use a release agent that will be effective at this temperature. Most mould release waxes will not perform well at this temperature and so we recommend never using mould release wax with prepregs. Instead, a chemical release agent should be used. Having ensured the mould is clean and free from contaminants. Apply the release agent according to the product's instructions.

Microtex surfacing ply has a special solid resin film on one side only which is laid against the mould surface.

### 2. Creating Cutting Templates

Working with prepreg material need that the reinforcement for a specific part can be accurately cut from the roll with minimum wastage. The way this is done is by creating cutting templates for the different plies of material. Create a template for a specific part once; simple cardboard templates are easy to make.

### 3. Cut Prepreg Material

If the prepreg has been storing in a freezer, before using it, ensure that is allowed it to thaw to room temperature in a sealed bag before removing it from the bag.

The backing ply can easily be marked using a permanent marker pen on the removable film.

Transfer the outline of the cutting template(s) first to the surfacing prepreg and then to the backing ply. Remember that the surface layer should be larger than the backing layer by a few millimetres all the way around to ensure that air can be fully evacuated from the laminate.

### 4. Putting Down the Surfacing Ply

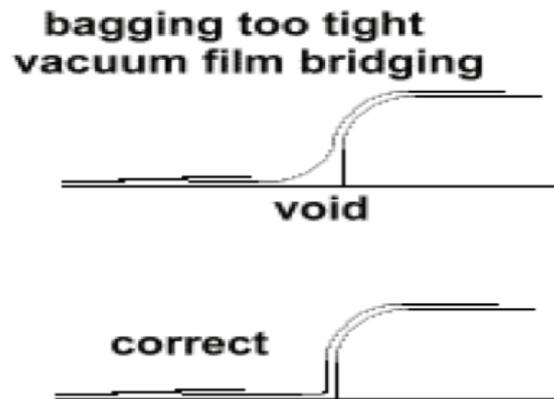
The resin film side of the material, or the side against the smooth peel ply, must be laid down against the mould's surface with the release film smooth side (not embossed) facing the mould.

Start conforming the prepreg to the mould by pressing and smoothing it down on the flatter areas of the mould.

Continue to work the prepreg, gently smoothing and shaping it into the contours of the mould.

The essential thing to ensure when putting down any layer of prepreg reinforcement (surfacing or backing) is that the material is firmly into all corners without any

'bridging' whatsoever. Because the prepreg has a precisely controlled amount of resin impregnated into it, there is no surplus resin to flow into and fill any gaps or voids so it is vitally important that when the prepreg is laid into the mould it is in intimate contact with the mould surface in all areas. The most likely problem experienced working with prepreg is 'pitting' on tight corners where the prepreg itself or the



vacuum bag has 'bridged'.

Find a range of different shaped blunt tools useful to help pressing the prepreg firmly into tight corners on the mould. Objects such as credit cards, ice scrapers, and even grouting tools are often used.

To create a perfectly straight seam at the back of the duct where the material meets, masking tape is used to mark a vertical line.

The surface ply can then be gently peeled away from the mould and cut perfectly along the tape line.

#### 5. Putting Down the Backing Ply

The backing ply or plies are laminated in a similar way to the surfacing ply however, because these layers will not be seen, careful alignment of the weave is not as important as it is (for cosmetic parts) for the surfacing ply.

Having cut the backing ply smaller than the surface ply, a small amount of surface layer should extend past the backing layer all the way around the mould.

A heat gun is certainly recommended when putting down the backing ply or plies where lightly warming prepreg before lamination will soften the resin and allow the material to drape more easily.

Just like with the surface ply, blunt tools are recommended to press the prepreg firmly into any tight corners of the mould.

Remember, just like with the surfacing layer it is essential that the backing layer or layers are firmly pressed down into all areas of the mould, especially tight or awkward corners. This operation is crucial for the good cosmetic aspect of the mould.

#### 6. Release Film

Once laminated all the plies of prepreg into the mould and with the feeling that all the material is in intimate contact with the mould surface (particularly any tight corners) proceed with the vacuum bagging process. The first layer of which is an unperforated

release film.

Cut off an adequately sized piece of unperforated release film to cover the surface of the mould in one piece. Use the cutting template created for the reinforcement as a guide but cut round the template making it at least 25 mm larger than the cut of the reinforcement.

Press the film over the whole surface of the part so that none of the prepreg is exposed. The only important thing at this stage is to ensure that the release film does not 'bridge' in any areas of the mould.

Use prepreg templates as a rough guide but ensure the cutting of release film at least 25-50mm oversize.

The film should comfortably cover the whole part. Don't worry if it's oversized or wrinkled but ensure the film is not 'tight' and does not 'bridge' anywhere on the part. Tape the edges of the release film onto the back of the mould with some masking tape to hold it in place.

Cut the release film some 25-50mm larger than the reinforcement, ensure that it overhangs past the edges of the laminate. Use this overhanging release film to wrap round onto the reverse of the mould and hold the film very loosely in place using masking tape. It is certainly not the right technique to pull the release film tight during the process of taping it in place as this would be likely to use up the excess of film that is preventing the film from bridging.

## 7. Breather Cloth

Cut a piece of breather cloth that is large enough to cover the whole surface of the mould in one piece, with a little surplus. Adding the breather is straightforward and none critical, providing it is there and it covers the whole mould surface.

Use small pieces of masking tape to loosely hold the breather cloth in place by taping it to the back of the mould. This also prevents sharp edges on the mould from accidentally puncturing the bag.

When positioning the breather cloth over the parts, pay attention to ensure that there is sufficient material, particularly in any difficult corners of the mould, to prevent it from bridging. The thick, felt-like nature of breather cloth makes precise positioning impossible so place the cloth in roughly the right place. Use some small strips of masking tape to secure the edges of the breather cloth to the reverse side of the mould to hold the cloth in place.

Roughly cut pieces of breather to cover part. The breather cloth should be cut at least 60mm oversized so that it can loosely wrap the part.

### IMPORTANT

Because when envelope bagging parts the vacuum bag will be pulled tight against both the front and the rear faces of the mould it is very important before the beginning the vacuum bagging process to ensure that the reverse side of the mould is free from any sharp edges, loose strands of reinforcement or anything else that might puncture the vacuum bag.

## 8. Make the Vacuum Bag

### Explanation of Envelope Bagging

When making small to medium sized prepreg parts the easiest way to vacuum bag them is to do so using an 'envelope bag' which is to say that the vacuum bag encloses

the whole mould, rather than being taped to the flange around the outside of it. There are several advantages to this method including the fact that large, airtight flanges are not required around the edge of prepreg moulds, split moulds do not need to be sealed together and multiple parts can easily be bagged and cured at the same time. Some disadvantages of this method are the use more bagging film, careful is needed when handling the bagged parts and very large parts are not practical to bag in this way because they need to be lifted and loaded inside the bag. On balance, it is almost always right to envelope bag prepreg parts, but be aware of these considerations.

### Bagging Technique

When cutting the bagging film to make the vacuum bag, be sure to cut plenty of material. A bag that starts off at least twice as big in all directions as the footprint of the part would be about right.

An 'envelope bag' completely encloses the part(s) instead of bagging film being pleated and taped to the mould's flange.

At this stage, seal 3 of the 4 edges. Press and squeeze the bagging tape very firmly to ensure an airtight seal.

Cut a sufficiently large piece of bagging film, leaving it double sided, and then apply tape all around any unsealed edges. Next, starting in one corner, peel the backing off the tape and start to seal the top of the bagging film to the bottom of the bagging film. Complete this until having three sealed edges and one unsealed edge that is large enough to be able to load the parts in through. Take time to ensure the bag tape is firmly stuck to the bag all the way around and inspect the seal for any gaps or small voids that may prevent the tape from making an airtight seal.

## 9. Loading the Parts and Positioning the Through-Bag Connector

When bagging more than one part at the same time

Carefully place the part(s) inside the open vacuum bag through the one unsealed side. If bagging more than one part at the same time ensure there is plenty of gap between the parts to ensure they have a surplus of bag each.

Load the part(s) into the envelope bag, facing upwards.

Ensure that the Through-Bag Connector is ready to connect directly to an 8mm ID Silicone Vacuum Hose.

Use PTFE tape when making any such connections to ensure an airtight seal. Without PTFE tape there is no way that the fittings will be airtight.

Clear PVC hose can be used during the pull-down but silicone hose must be used in the oven.

A Through-Bag Connector (sometimes known as a 'breach unit' or 'vacuum valve') is used to connect the vacuum pump to the vacuum bag. No resin will be drawn through this connection to risk fouling it so the Through-Bag Connector is a sturdy and well-engineered piece of equipment.

The Through-Bag Connector needs to be positioned on top of a piece of breather cloth which also leads to the breather cloth of the part or parts to be vacuum bagged. This ensures that air can flow freely from the Through-Bag Connector to the breather on the parts. When bagging several parts at once will occur to cut short strips of breather and use them to connect the Through-Bag Connector to the various parts.

Do not position the Through-Bag Connector directly on top of a part, instead sit it on a piece of breather in a gap in the vacuum bag.

Snip off the top 5mm of the peak to make a circular hole in the film of about 12mm.

Screw the two halves together tightly to complete the through-bag connector fitment.

Use fingers to make a small peak in the vacuum bag directly above where the Through-Bag Connector will be positioned. Use scissors to snip about 5mm off the top

of the peak to make a small round hole in the vacuum bag.

Position the connector in a gap in the bag, on some breather connected to the part(s).

Pass the threaded part of the connector through the hole in the film and place the other half inside the bag.

Unscrew the two halves of the Through-Bag Connector. Put the wider, flatter section of the Through-Bag Connector inside the bag and then pass the threaded part of the upper section through the hole cutted in the bag. Screw the inside section back onto the outside section and tighten the connector firmly.

#### 10. Complete the Vacuum Bag

Complete the vacuum bag by removing the backing from the vacuum bagging tape on the last remaining side of the bag and press the bag firmly onto the tape.

#### 11. Vacuum Bag Pull-down

The single most important part of the prepreg manufacturing process, particularly when working out-of- autoclave, is the vacuum bagging process. How well is done the vacuum bag will essentially determine whether parts are perfect, rejects or somewhere in-between. The reason for this is because vacuum pressure alone is only just sufficient to make perfect prepreg parts. If any area of the vacuum bag 'bridges' it will significantly reduce the pressure the bag exerts on the laminate; without the full vacuum pressure in these areas the laminate will 'void' and appear pitted. For this reason, extreme care and lots of time should be spent on this part of the process to ensure the best possible results.

After removing some of the air, start to position the bag particularly in difficult areas like the underside of this duct.

Start by connecting the Through-Bag Connector to the vacuum pump using a length of 8mm ID Silicone Vacuum Hose (silicone hose is mandatory inside the oven).

Switch the vacuum pump on and begin to evacuate some of the air from the vacuum bag. Close the 1/4 Turn Valve on the pump or the bag to isolate the vacuum once the bag has just started to take shape. Carefully but forcefully move and position the bag to ensure a surplus of bag is available over the whole mould

Pay particular attention to awkward corners where 'collect' extra bag so ensure it's not possible for the bag to bridge. The whole surface should have an excess of bag.

Open the valve again to draw some more air out and repeat the process all over again. Keep doing this until reached full vacuum in the bag. We would usually take several steps of opening and closing the vacuum and positioning and pushing the bag before we reach full vacuum.

Correctly bagged parts under full vacuum. Plenty of wrinkles show there is an excess of bag on both parts.

Push plenty of 'wrinkles' of bag into difficult shapes like the underside of this duct. The more wrinkles the better!

Pay close attention to the seal on the bag, listening for any leaks. Often it takes several minutes of going round and round the bagging tape to find every last little leak but it is essential to do this because this process requires a perfectly sealed vacuum bag in order to be successful.

Open and close the valve on the pump or the vacuum bag, listening carefully to the vacuum pump. If the bag is perfectly sealed there should be no change in note when opening and closing of the valve. If the sound of the pump changes in any way when opening and closing the valve then that is a sure indication that there is a leak, however small, somewhere in the bag (usually the seal but sometimes the fittings and

sometimes a puncture in the bag itself. Ignoring a leaking bag then the end result is very unlikely to be as hoped.

If the bag seems to be completely sealed and cannot hear any change in the pump's tone when opening and closing the vacuum valve then proceed to perform a vacuum leak 'drop-test'.

## 12. Vacuum Leak Drop-Test

This test will identify any tiny leaks that can be beyond the scope of any other means of detection (including the pump 'pitch change' test, leak-flow indicators and ultrasonic detectors).

With the bag at full vacuum, close the vacuum valve on the Through-Bag Connector and switch off the vacuum pump. Wait 30 minutes and see how the bag feels; it should still feel perfectly tight. When doing this, if a change in the tone of the vacuum pump is not heard then the bag is perfectly sealed

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It is recommended to have a hole through the side of the oven through for pass a vacuum hose so that an active vacuum connection can be maintained to the parts throughout the curing process then in practice, a very tiny leak will sometimes not damage the finished parts. If the bag still felt tight after the drop test but a tiny change in the pumps not was detectable when opening the valve then this sort of micro-leak can probably be overcome. If, however, the bag actually feels slack after the drop-test then the leak needs to be found or the whole part re-bagged.

## 13. Loading into the Oven for Curing

Having successfully performed the drop-test now is possible to cure the parts. Microtex prepregs can be normally cured at a range of temperatures from about 85°C to 140°C. For the best results, a cure temperature of 100°C for a period of 4hrs is suggested. Higher temperatures will cure the prepreg much quicker but will require more specialist mould materials and may also reduce the surface finish quality of the cured parts.

Ensure having a shelf or platform within the oven on which can position the parts. Be sure that the parts can be positioned within the centre, that there will be sufficient space all around to allow for good airflow and avoid any contact of the vacuum bag with sharp edges of the oven.

Pre-heat oven to 100°C and ensure that vacuum bag is at full vacuum pressure before closing the vacuum valve on the pump and disconnecting the vacuum hose. making it possible to cure multiple parts at the same time in an oven.

A Vacuum Leak-Flow Indicator positioned in-line with the silicone hose on the outside of the oven is a very useful visual indication of any problems occurring inside the oven (such as a leak developing or a burst bag). The Vacuum Leak-Flow Indicator should never be spinning; if it starts spinning a problem has occurred that will need to be rectified (sometimes an emergency strip of bagging tape can seal a puncture).

## 14. De-moulding

Once the parts have cooled to room temperature the vacuum bag, film and breather can be removed from the parts and they can be de-moulded.

To release the parts from the mould simply start at an edge and using something none-marking like a plastic scraper, tease a corner of the part away from the mould.