

> DURATOOL[®] 450 BMI TOOLING PREPREG

TECHNICAL DATA SHEET



DESCRIPTION

DURATOOL 450 is a proven, high-performance bismaleimide resin/carbon fiber tooling system that is capable of continuous service at 375°F (190°C) and short cycle service at 400°F (204°C).

DURATOOL 450 allows high-quality tooling laminates to be produced directly from a high-temperature master models or a variety of intermediate materials. After autoclave processing for the initial cure, the tool laminate can be de-molded and post-cured "free-standing".

DURATOOL 450 is supplied in roll form with a standard roll length of 50 yards (50 meters). Standard material width is 50 inches (1000 – 1250mm). Materials are shipped frozen and in insulated boxes.

FEATURES & BENEFITS

- Proven capable of more than 1000 autoclave cycles at 375°F (190°C) without deterioration
- Manufactured to ensure uniform resin distribution in fabrics with <1% volatile content
- Formulated for long term thermal oxidative stability during normal 375°F (190°C) service
- Exhibits low and predictable shrinkage allowing manufacturing process design to net size tool
- Closely matches the thermal expansion coefficient of composite parts reducing dimensional inaccuracies and residual stress levels
- Determined safe to use via extensive toxicological screening (contains no MDA or VCHDs)

SUGGESTED APPLICATIONS

- Ideal for multiple-tool/high-production-rate manufacture of composite components

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CHARACTERISTICS & PROPERTIES

Table 1 | Carbon Prepreg Characteristics

Property	CP 200	CP 365	CP 380 ¹
Weave Style	2x2 Twill	2x2 Twill	2x2 Twill
Fabric Weight, gsm	200	365	380
Warp, ends/in (ends/cm)	12.5 (4.92)	11.7 (4.61)	12.0 (4.73)
Fill, ends/in (ends/cm)	12.5 (4.92)	11.7 (4.61)	12.0 (4.73)
Prepreg Weight, gsm	345	562	593
Resin Weight, %	42	35	36
Volatile Content, %	<1	<1	<1
Shelf Life at 0°F (-18°C), months	>24	>24	>24
Tack Life at 68°F (20°C), days	28	28	28
Work Life at 68°F (20°C), days	45	45	45
Gel Time at 350°F (177°C), minutes	10	10	10
Cured Ply Thickness, autoclave, in (mm)	0.009 (0.23)	0.014 (0.36)	0.015 (0.38)

¹ Primarily supplied by Cytec Engineered Materials European facilities

Table 2 | Carbon Tooling Laminate Properties

Property	Value
Tg, °F (°C)	565 (296)
Shrinkage, %	0.030
CTE, °F ⁻¹ (°C ⁻¹)	1.4x10 ⁻⁶ (2.5x 10 ⁻⁶)
Void Content: Autoclave, %	< 0.5

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MANUFACTURING PROCEDURES FOR AUTOCLAVE CURED LAMINATES

These procedures are designed to produce consistent, high-quality tooling laminates. Minor deviations can have unexpected and undesirable effects on the final product. Please consult Cytec Engineered Materials before deviating from these procedures.

Master Model/Intermediate Construction

- A master model/intermediate constructed of monolithic graphite, epoxy composite or Invar[®] is recommended
- The master model/intermediate should be soundly constructed to withstand the autoclave cycle. Solid models are preferred, but hollow models may be used if they are suitably sealed. Hollow models should never be enveloped bagged
- The master model/intermediate should be cycled at temperature and pressure above that of the DURATOOL 450 cure cycle before beginning lay-up of the tool. Any leaking, softening or out gassing of the master model/intermediate during tool cure can degrade the performance of the finished product

Master Model/Intermediate Preparation Procedure

The following steps should be completed to prepare the surface of the master model/intermediate for tool lay-up:

1. Seal the surface of master model/intermediate with a high-temperature surfacing resin as required to eliminate any porosity
2. Thoroughly degrease the master model/intermediate surface ensuring all solvent is removed
Thorough degreasing may require use of elevated temperature.
3. Apply a semi-permanent, solvent-based release sealer such as Frekote[®] B-15 to the master model/intermediate surface
4. Apply multiple coats of a high-temperature release agent such as Frekote[®] 700 NC to the master model/intermediate surface following the manufacturer's instructions
5. Apply 1/4 inch (6.0mm) perimeter dam of silicone rubber/self-adhesive wax or similar to the master model/intermediate surface to define the edge of the tool

Prepreg Thawing Procedure

- Allow the prepreg rolls to warm to room temperature before opening the protective bag
Prepreg rolls are considered sufficiently warm when condensation is no longer visible on the outside of the bag.
- Do not remove the prepreg rolls from the freezer and leave them out overnight
- Ensure sufficient material is available to complete the job allowing for 10 – 15% scrap

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General Lay-up Instructions

- Materials should be laid up in accordance with the laminate schedules in Figure 1 and Figure 2
- Cleanliness is very important during the lay-up procedure. Avoid introducing any contaminants into the lay-up, i.e. paper, polythene or release film, as these will adversely affect the tool laminate and may lead to premature tool failure
- To avoid bridging, no single piece of prepreg should ever be laid up around more than one corner
- To avoid wrinkling, ensure that prepreg is spliced in corners and any female tight radii
- Overlap joints of 1/8 inch to 1/4 inch wide (3.0mm to 6.0mm) are recommended on the first ply only. Butt jointing is preferable on subsequent plies but care must be taken so that the joints on each ply are staggered (do not occur above one another). If overlapping is unavoidable on subsequent plies ensure the overlap is a maximum of 1/8 inch (3.0mm) wide and that overlaps are staggered

NOTE: The tool must be laid up and cured within the work life of the first ply of prepreg.

Tool Lay-up Procedure

- Lay the first ply of prepreg on the master model/intermediate surface oriented at 0°
The initial choice of which direction will be 0° is arbitrary, but, once chosen, subsequent angles must be measured relative to this direction.
- Debulk the lay-up per the following steps:
 - Cover the lay-up with a suitable P3 release film (e.g. FEP) ensuring no bridging
 - Lay 7781, 7500 or equivalent glass fabric over the release film to act as a breather
Ensure no bridging of the glass fabric by cutting the fabric to fit complex areas.
Do not use a non-woven polyester breather unless a peel ply is first applied over the release film. Filaments from the polyester breather left in the laminate may cause premature tool failure.
 - Apply a vacuum bag, pull a minimum of 25 inches Hg vacuum and hold as indicated in Table 3

Table 3 | Debulk Cycle Hold Times

Ply	Debulk Hold Time
First	60 minutes
Second through final	30 minutes

- Remove vacuum bag and breather materials and set to one side for future use
- Lay the second ply of prepreg oriented per the appropriate laminate schedule
 - Continue lay-up of plies per the appropriate schedule, debulking when called for as described in Step 2

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DURATOOL 450 0.40 inch (10mm) Tool Laminate

Ply No.	Dir. (°)		Material Type
26	45	▬	6K 365/380 2X2T
25	0	▬	6K 365/380 2X2T
DEBULK			
24	45	▬	6K 365/380 2X2T
23	0	▬	6K 365/380 2X2T
22	45	▬	6K 365/380 2X2T
21	0	▬	6K 365/380 2X2T
20	45	▬	6K 365/380 2X2T
DEBULK			
19	0	▬	6K 365/380 2X2T
18	45	▬	6K 365/380 2X2T
17	0	▬	6K 365/380 2X2T
16	45	▬	6K 365/380 2X2T
15	0	▬	6K 365/380 2X2T
DEBULK			
14	45	▬	6K 365/380 2X2T
13	0	▬	6K 365/380 2X2T
12	45	▬	6K 365/380 2X2T
11	0	▬	6K 365/380 2X2T
10	45	▬	6K 365/380 2X2T
9	0	▬	6K 365/380 2X2T
8	45	▬	6K 365/380 2X2T
7	0	▬	6K 365/380 2X2T
DEBULK			
6	45	▬	6K 365/380 2X2T
5	0	▬	6K 365/380 2X2T
4	45	▬	6K 365/380 2X2T
3	0	▬	6K 365/380 2X2T
2	45	▬	6K 365/380 2X2T
DEBULK			
1	0	▬	6K 365/380 2X2T
MODEL			

Figure 1 | Suggested 0.40 inch (10mm) Laminate Schedule for Tools with Machined Surface

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DURATOOL 450 0.25 inch (6.4mm) Tool Laminate



















Ply No.	Dir. (°)		Material Type
DEBULK			
18	0		3K 200 2X2T
17	0		6K 365 2X2T
16	45		6K 365 2X2T
15	45		6K 365 2X2T
DEBULK			
14	0		6K 365 2X2T
13	0		6K 365 2X2T
12	45		6K 365 2X2T
11	45		6K 365 2X2T
DEBULK			
10	0		6K 365 2X2T
9	0		6K 365 2X2T
8	45		6K 365 2X2T
7	45		6K 365 2X2T
DEBULK			
6	0		6K 365 2X2T
5	0		6K 365 2X2T
4	45		6K 365 2X2T
3	45		6K 365 2X2T
2	0		6K 365 2X2T
DEBULK			
1	0		3K 200 2X2T
MODEL			

Figure 2 | Suggested 0.25in (6.4mm) Laminate Schedule

Final Bagging Procedure

Bag the completed tooling laminate according to the following steps. Refer to Figure 3 and Figure 4 for details.

1. Place two or more thermocouples into the prepreg between ply 1 and ply 2, ideally situated near the thickest part of the master model and in a trim area
2. Remove the perimeter dam from around the tool laminate

Ensure the edge of the laminate is neatly trimmed to allow for breathing.

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3. Create “breather dam” sections by wrapping 200gsm [2 – 4in (50 – 100mm)] wide fiberglass boat cloth around strips of bag sealing compound, leaving 50 – 60% of one side of the sealant exposed (Refer to Figure 3, steps a, b and c)
4. Place the “breather dam” in contact with the edge of the laminate securing it in place with the exposed portion of the sealing compound
The loose boat cloth should extend over the top of the sealing compound away from the tool laminate (Refer to Figure 3, step d)
5. Stack sufficient layers of “breather dam” on top of each other so that they extend 1/8 inch (3.0mm) higher than the laminate thickness (Refer to Figure 4)
As resin flows into the boat cloth during cure the vacuum paths will close eliminating excess resin bleed.
6. If secondary bonding to the tool laminate is required, cover the laminate with porous Teflon[®] coated fiberglass or peel ply designed for use with BMI materials
Extend the fiberglass/peel ply to the edge of the laminate ensuring no bridging.
7. Cover the laminate with a continuous layer of non-perforated FEP release film
Extend the release film over the breather dam sealing tucks and folds with high temperature adhesive tape.
8. Tape the release film in place ensuring a minimum of 1 inch (25mm) of boat cloth from each of the “breather dam” layers is exposed so that it can contact the breather pack
9. Apply the breather pack using 280gsm non-woven polyester ensuring no bridging
Ensure the breather extends over the boat cloth layers from the “breather dams”.
10. Locate a minimum of two vacuum ports on breather pads, for a laminate up to 20 square feet (2 square meters) and another port for each additional 10 square feet (1 square meter)
Always use an even number of vacuum ports.
Do not locate vacuum ports directly on top of the laminate. Position them against the master model/intermediate or in tucks in the vacuum bag ensuring they are connected to the breather pack.
11. Using a second non-perforated FEP release film layer, cover the tool and breather to protect the vacuum bag film
Do not block the vacuum path from ports to the breather pack.
12. Vacuum bag the lay-up using a good quality BMI-resistant bagging film (e.g., PTFE or Nylon 66) ensuring no bridging
13. Check the vacuum integrity by pulling a full vacuum (28” Hg) then disconnecting the vacuum source
If the bag loses more than 2 inches of Hg in 15 minutes check and seal leaks.
14. Maintain 28” Hg vacuum and debulk the laminate for at least 12 hours for large tools

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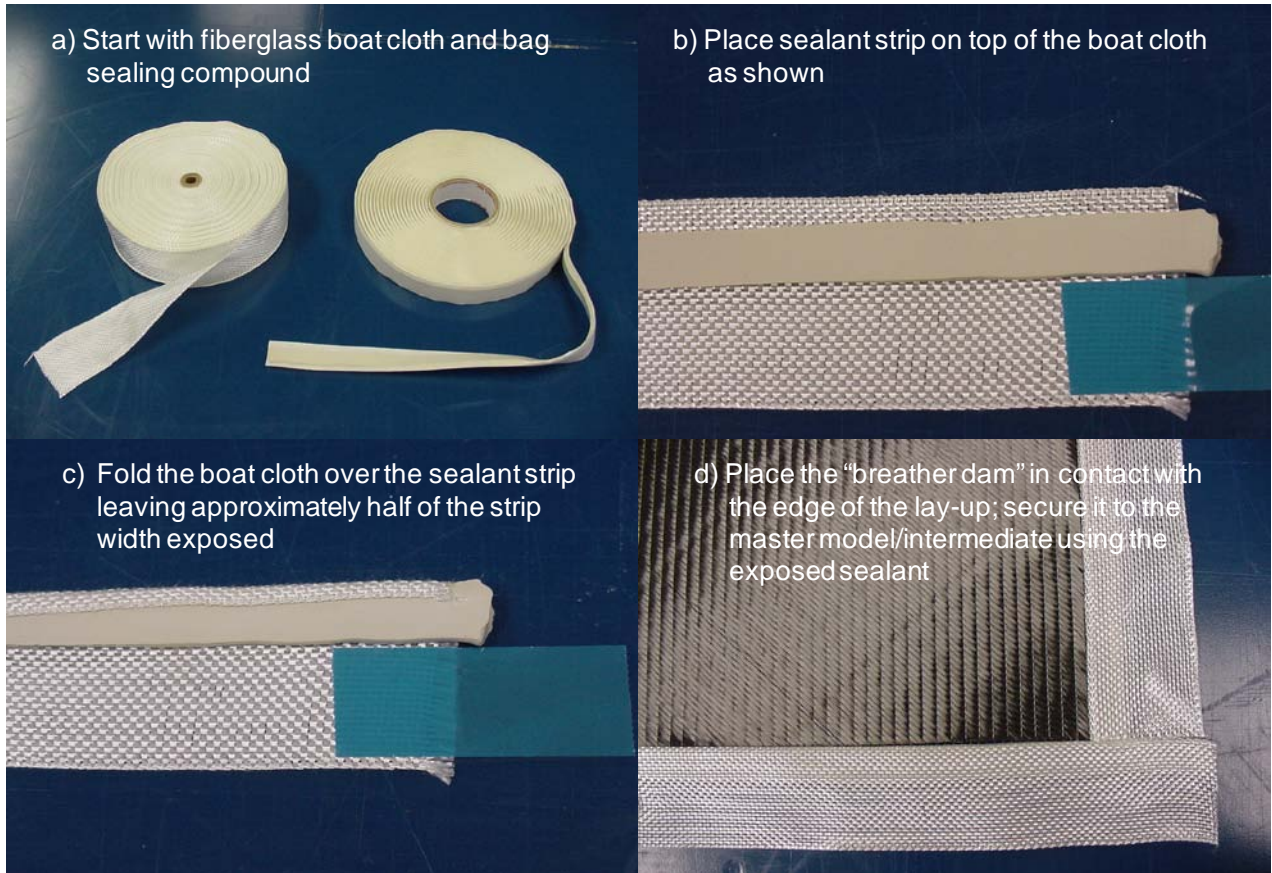


Figure 3 | Creation of "Breather Dam" Assembly

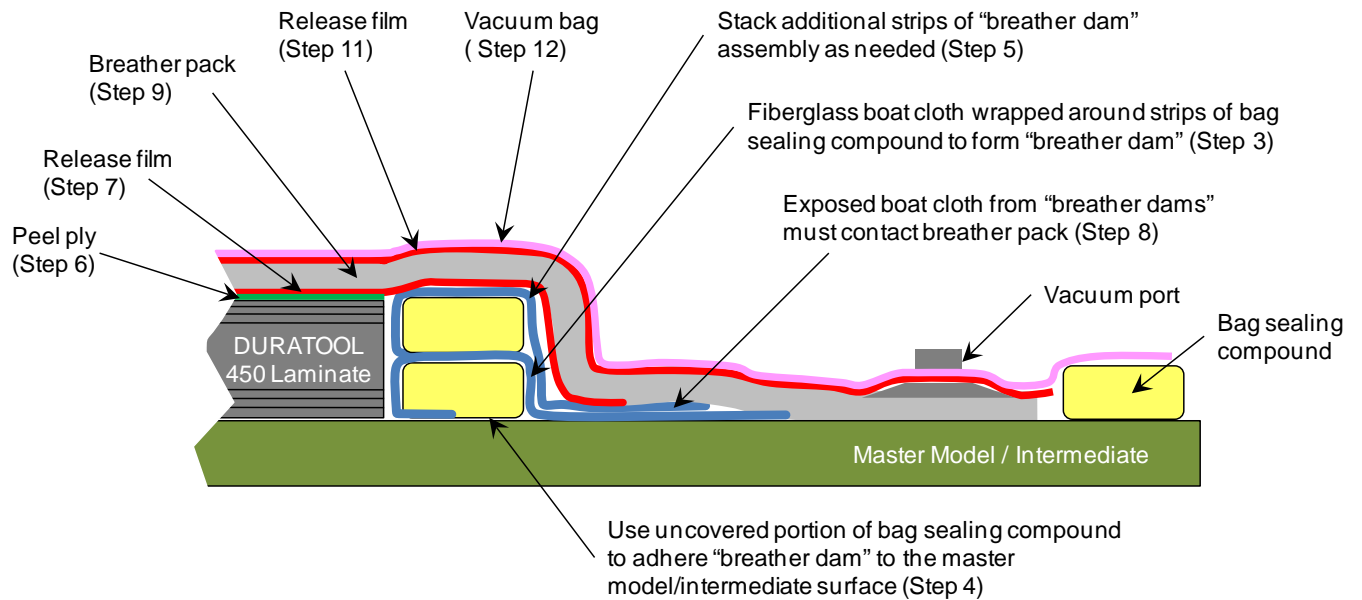


Figure 4 | DURATOOL 450 Bagging Scheme
Step numbers refer to Final Bagging Procedure section

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Recommended Cure Procedure

1. Apply a minimum of 28" of Hg vacuum
2. Apply a minimum of 90 psi (6 bar) autoclave pressure [90+ psi (6+ bar) preferred] with full vacuum
3. Heat the laminate at a rate of 2 – 4°F/minute (1 – 2°C/minute) until the lagging thermocouple reaches a cure temperature of 350 ± 5 °F (177 ± 3°C)

To promote even heat up do not allow autoclave temperature to exceed 20°F (10°C) above the cure temperature.

4. Hold the laminate at 350 ± 5 °F (177 ± 3°C) for a dwell time of 6 hours minimum
5. Cool the laminate under pressure to 140°F (60°C) at 5°F/minute (3.0°C/minute) maximum rate

Release Procedure

1. Remove the bagging materials from the laminate

Remove peel ply at this time only as necessary to allow backing structure attachment.

2. Attach support structure if desired

All composite tools require some kind of support structure. This may take the form of an extended flange or a complex structure designed to prevent deflection under normal service conditions. These usually fall into one of three categories.

- **Egg crate structures:** This kind of structure is prefabricated from either solid or honeycomb cored composite panels and can be applied before demolding or after post-cure. Attachment is by wet lay-up "cleats", silicone RTV adhesive or mechanical fasteners. The structure should be spaced 1/8 inch (3mm) away from the back face of the tool laminate.
 - **Tubular structures:** This kind of structure is also prefabricated using composite tube sections and can be applied before de-molding or after post-cure. Attachment is by wet lay-up "cleats" or mechanical fasteners. Additional pads are usually added to the back of the tool laminate to spread loads at the local attachment points.
 - **Integral stiffeners:** This method can provide a very quick and cost effective support structure when used in conjunction with an inexpensive metal support trolley. In addition, accuracy benefits can be obtained by effectively "locking" the tool into shape on the model thereby reducing spring in/out during post-cure.
3. Carefully release the laminate around its entire periphery and ease it off the master model/intermediate

Always use "soft" plastic wedges; never use metal chisels or scrapers.

NOTE: In its partially cured state the tool laminate will be brittle. Do not attempt any trimming or finishing operations or use any solvents on the laminate until after post-cure.

Post-cure Procedure

Post-cure of the tool laminate is critical to the long-term performance of the tool. Do not try to rush or omit any of the following the steps.

1. Attach thermocouples to the tool and place it in an oven
2. Heat tool at 2 – 3°F/minute (1 – 2°C/minute) to 440°F (226°C)
3. Hold the tool at 440°F (226°C) for 6 hours
4. Cool tool to 140°F (60°C) at 2 – 3°F/minute (1 – 2°C/minute)

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Putting the Tool into Service

1. Clean the tool surface to remove all traces of the release used during manufacturing
A cleaner such as a mild cutting/polishing compound is recommended (e.g., Frekote[®] PMC). Wiping with solvent will not remove wax.
2. For new tools and after refurbishment of older tools, apply 2 or 3 coats of a tool surface sealer such as Frekote[®] B-15 per manufacturer's instructions

For best results cure the final coat of tool surface sealer at the end use temperature of the tool.

3. Apply a production release agent per manufacturer's instructions

The tool is now ready for 375°F/400°F (190°C/204°C) service.

PRODUCT HANDLING AND SAFETY

Cytec Engineered Materials recommends wearing clean, impervious gloves when working with prepreg materials to reduce skin contact and to avoid contamination of the product.

Materials Safety Data Sheets (MSDS) and product labels are available upon request and can be obtained from any Cytec Engineered Materials Office.

DISPOSAL OF SCRAP MATERIAL

Disposal of scrap material should be in accordance with local, state, and federal regulations.

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