

ES161/ES161S

EPOXY MATRIX

GENERAL FEATURES

ES161/ES161S is an advanced epoxy matrix system designed for composite tooling construction.

MAIN CHARACTERISTICS

ES161/ES161S is supplied in the form of both glass and carbon pre-preg to offer the following advantages:

- low temperature cure: 14 hours at 45°C
- excellent surface finish
- work life of 2-3 days at room temperature (23°C) and 6 months when stored at -18°C
- low shrinkage during the curing and post-curing process
- service temperature over 180°C after post-cure

PROCESSING INFORMATION

MASTER MODEL SELECTION

Master model material should be selected with reference to the temperature and pressure to be applied during the autoclave cure process. In all cases the master must be proved at the temperature and pressure above that of the desired cure cycle before beginning lay-up of the tool. This will enable any potential problems such as lack of vacuum integrity or poor stability under pressure to be checked before any actual laminate construction. The master model must be constructed from materials that will not cause adverse reactions with the tooling prepreg resin system. Equally, it should not be coated with a sealer that will allow migration of chemicals which cause problems.

MASTER MODEL PREPARATION PROCEDURE

- Thoroughly degrease the master surface using an organic solvent;
- Seal the surface of master model with a suitable epoxy surfacing resin using wipe on buff off technique;
- Thoroughly degrease the master model surface ensuring all solvent is removed;
- Apply a semi-permanent, solvent-based release agent such as Frekote® 700 NC to the surface following the manufacturer's instructions;
- Allow the final coat to cure for 15 to 20 minutes at 22°C;

THAWING PREPREG BEFORE USE

CIT prepregs must be stored at -18 °C, sealed in original packages. Shop life at 23°C refers to rolls sealed in original packages. Before using the prepreg, remove the roll from the freezer and let it warm up to room temperature for 6 hours sealed in its original package. Prepreg rolls are considered sufficiently warm when condensation no longer forms on the outside of the bag. Ensure there is adequate material available to complete laminating and cure, prior to unsealing the roll and starting work.

OPERATIONAL INSTRUCTIONS

- Always wear nitrile gloves when handling prepreg;
- Cut the prepreg into convenient sized squares or rectangles for laminating;
- Cut 45° trim strips for the external corners and tight radii;
- 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;
- Table 1 shows a copy of a typical customers work sheet with easy reference for ply type and fibre orientation.
- Lay up the first ply, carefully cutting and keep in mind the following points:
 - A. All pieces should be overlap of 1/8 inch (3,0mm)
 - B. Lay up a series of 45° trim strips in to all external corners and tight radii, ensure pattern runs in a consistent direction for aesthetics;
 - C. Cut material to fit into all external radii and corners taking care not to disturb the trim strips.
 - D. To avoid bridging, no single piece of prepreg should ever be laid up around more than one corner;
 - E. Ensure that Prepreg is spliced in corners and any female tight radii in order to avoid wrinkling.
- Lay up the bulk plies following these instructions:
 - A. Butt jointing is preferable on subsequent plies but care must be taken so that the joints on each ply are staggered with a minimum of 18 mm (3/4 inch) spacing for adjacent plies.
 - B. 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.
 - C. Under no circumstances should any gaps be left as this is likely to cause voids in the completed tool.

DEBULKING

It is essential to debulk the prepreg at least at the stages stated in table 1.

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, but in these cases, the time factor must be taken into consideration.

Debulk the lay-up per the following steps:

1. Cover the lay-up with a suitable (P3 type) perforated release film (e.g. FEP) ensuring no bridging and extending beyond the lay-up by approximately 25mm (1 inch);
2. Apply a breather fabric style 7781, 7500 or equivalent glass fabric over the release film. Tailor to fit avoid bridging. 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.
3. Cover the laminate/assembly with a vacuum bag and apply full vacuum of 948 mbar (28 inches Hg) for a minimum of 30 minutes.
4. Care must be taken when materials are removed from the surface afterwards, be careful not to lift up the previously laminated plies.

TYPICAL LAY-UP SEQUENCE AND OPERATION FOR A CARBON FIBER REINFORCED

LAMINATE OF TOTAL THICKNESS 5.60 MM (0.22")

Operation N°	Ply Orientation	Material / Operation	Signed	Inspected
1	0°	CC206 ES161		
2		DEBULK		
3	0°	CC631 ES161		
4	+45°	CC631 ES161		
5		DEBULK		
6	-45°	CC631 ES161		
7	90°	CC631 ES161		
8	90°	CC631 ES161		
9		DEBULK		
10	-45°	CC631 ES161		
11	+45°	CC631 ES161		
12	0°	CC631 ES161		
13		DEBULK		
14	0°	CC206 ES161		

The initial choice of the direction which will be 0° is arbitrary, but, once chosen, subsequent angles must be measured relative to this direction.

- CC206 ES161 is a 204 g/m², 2x2 twill, 3k carbon fabric with 50% resin content
- CC631 ES161 is a 630 g/m², 2x2 twill, 12k carbon fabric with 35% resin content

REDUCED LAY-UP SEQUENCE AND OPERATION FOR A CARBON FIBER REINFORCED

LAMINATE OF TOTAL THICKNESS 5.50 MM

Operation N°	Ply Orientation	Material / Operation	Signed	Inspected
1	0°	CC206 ES161		
2		DEBULK		
3	0°	CC995 ES161S		
4	45°	CC995 ES161S		
5		DEBULK		
6	0°	CC995 ES161S		
7	45°	CC995 ES161S		
8		DEBULK		
9	0°	CC995 ES161S		
10	0°	CC206 ES161		

The initial choice of the direction which will be 0° is arbitrary, but, once chosen, subsequent angles must be measured relative to this direction.

- CC206 ES161 is a 204 g/m², 2x2 twill, 3k carbon fabric with 50% resin content
- CC995 ES161S is a 995 g/m², 2x2 twill, 24k carbon fabric with 34% resin content

TYPICAL LAY-UP SEQUENCE AND OPERATION FOR A GLASS FIBER REINFORCED LAMINATE OF TOTAL THICKNESS 5.50 MM (0.217")

Operation N°	Ply Orientation	Material / Operation	Signed	Inspected
1	0°	EE300 ES161		
2		DEBULK		
3	0°	EE771 ES161		
4	45°	EE771 ES161		
5		DEBULK		
6	45°	EE771 ES161		
7	0°	EE771 ES161		
8	0°	EE771 ES161		
9		DEBULK		
10	45°	EE771 ES161		
11	45°	EE771 ES161		
12	0°	EE771 ES161		
13		DEBULK		
14	0°	EE300 ES161		

The initial choice of the direction which will be 0° is arbitrary, but, once chosen, subsequent angles must be measured relative to this direction.

- EE300 ES161 is a 300 g/m², 8H satin glass fabric with 43% resin content
- EE771 ES161 is a 770 g/m², 4H satin glass fabric with 33% resin content

CURE PROCESS RECOMMENDATIONS

The curing cycles recommended are:

1. 14h@45°C, ramp 0,5°C/min:

- Dwell at RT for 60 minutes under full vacuum
- Apply a pressure of 6 bar
- Heat the laminate at a rate of 0.5°C/min to 45°C
- Hold the laminate at 45°C for 14 hours
- Cool the laminate to RT under pressure at 2°C/min

The Tg of the laminate made using this cure cycle is 63°C (by DMA onset).

2. 7h@55°C, ramp 0,5°C/min:

- Dwell at RT for 60 minutes under full vacuum
- Apply a pressure of 6 bar
- Heat the laminate at a rate of 0.5°C/min to 55°C
- Hold the laminate at 55°C for 7 hours
- Cool the laminate to RT under pressure at 2°C/min

The Tg of the laminate made using this cure cycle is 72°C (by DMA onset).

Temperature °C (°F)	Time	Tg °C (°F) DSC
45 (113)	14h	69 (156)
55 (131)	7h	75 (167)

POST-CURE

An unsupported post cure can be applied to reach the necessary service temperature of the carbon tool. All the cycle below are performed with a 0,2°C/min heating ramp:

Cure	Postcure	Tg °C (°F) E' DMA	Tg °C (°F) tan δ DMA	% cure by DSC
14h @45°C	5h @ 180°C	189 (372)	222 (432)	100%
7h @55°C	5h @ 180°C	191 (376)	228 (442)	100%

BAGGING & LAY-UP RECOMMENDATIONS

1. The tool master should be sealed and coated with release agent.
2. When the prepreg is laid up on the mold, splices should be staggered.
3. Small strips of prepreg can be placed in tight corners and radii to insure that there is no bridging of the Prepreg.
4. A thermocouple should be placed under the second ply, in an area that is not critical to the aesthetics of the part.
5. A Non Perforated release film is placed on the top of the last layer of prepreg.
6. Pin prick the solid release film every 100-150mm across the surface of the tool. This is to form vacuum connections to the breather.
7. Breather cloth, minimum 300gsm weight, is applied of the entire part, with a double layer where the vacuum ports are attached.
8. The vacuum bag is placed over the part with sufficient slack to avoid bridging in corners.
9. Perform a vacuum check to insure there are no leaks and that > 914 mbar vacuum (27 in Hg) is achieved.

SAFETY CONSIDERATIONS

- Please consult the Material Safety Data Sheet.
- This product contains epoxy resin and may cause allergic reaction.
- The use of latex gloves for handling is recommended.
- Waste material should be discarded following national law.

DELIVERY FORM AND PACKAGING

Custom widths, roll size, and packaging are available on request.

Prepreg fabrics: Supplied on 75 mm (3") diameter cardboard cores with release paper on one side and polyethylene film separator on the other side. Rolls are sealed plastic bags and packed in cardboard boxes.

Standard width: 100 cm or 127 cm (50 "). **Standard length:** 50 m (50 ln yds).

Unidirectional Prepreg: Supplied on 300 mm (12") diameter cardboard cores with release paper on one side and smooth polyethylene film separator on the other side. Rolls are sealed in plastic bags and packed in cardboard boxes.

Standard width: 60cm (from 30 cm up to 105 cm).

Standard length: 100 m.

Shipment: Product should be shipped at $< -18\text{ }^{\circ}\text{C}$ ($< 0\text{ }^{\circ}\text{F}$)

HANDLING AND CONDITIONING

- Store rolls at $-18\text{ }^{\circ}\text{C}$, sealed in original packages.
- Shop life at 23°C refers to rolls sealed in original packages.
- Before using the prepreg, remove the roll from the freezer and let it warm up to room temperature for 6 hours sealed in its original package.

IMPORTANT NOTICE:

The data and statements supplied in this datasheet are met to provide an overview of this product and its properties. Users should perform their own verification and testing to determine suitability of this material for their specific end use applications. NO WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE IS EXPRESSED OR IMPLIED. Nothing herein is to be taken as permission to practice any patented invention without a licence.

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Toray Group

Composite Materials (Italy) s.r.l. - Socio Unico

Via Quasimodo, 33 - 20025 Legnano (MI) ITALY

Capitale Sociale € 100.000 I.V. - R.E.A. MI n° 2052698

Iscrizione Registro Imprese C. F. n° 08844870967

P.IVA IT08844870967

Phone: +39 0331.467.555 • Fax: +39 0331.467.777

E-mail: info@composite-materials.it

www.composite-materials.it