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185HR Processing Guide

The processing guidelines contained in this document were developed through in-house testing and field experience. However, they *should be considered to be starting points that will require further adjustment.* Read the following review of processes for applicability to your particular Printed Wiring Board (PWB) fabrication environment. Remember that the suggestions contained herein can not account for all possible board designs or processing environments. Additional adjustments by the fabricator will be necessary. Isola can and will assist with this process, but the fabricator, not Isola, is ultimately responsible for their process and the end results. Fabricators should verify that PWBs made using these suggestions meet all applicable quality and performance requirements.

Part 1: Prepreg Storage and Handling

Isola Group's prepreg bonding sheets for use in multilayer printed circuit board applications are manufactured to specifications that include physical and electrical properties and processing characteristics relative to the laminating application. Handling and storage factors have an important influence on the desired performance of the prepreg. Some parameters are affected by the environment in which prepregs are stored. They can also deteriorate over extended periods of storage. The prepreg received by the customer is a glass fabric that has been impregnated with a stated quantity of low volatile, partially polymerized resin. The resin is tack-free but somewhat brittle. Many lamination problems arise from resin loss off the fabric due to improper handling. The fabric used is based on the order and supplies the required thickness. In most cases the amount of resin carried by the fabric increases as the fabric thickness decreases.

Handling Suggestions

Handle all prepreg using clean gloves. Use sharp, precision equipment when cutting or paneling prepreg. Treat all prepreg as being very fragile. Use extreme care when handling very high resin content prepreg (glass fabrics 1080 and finer).

Storage Suggestions

Upon receipt, all prepreg should be immediately moved from the receiving area to a controlled environment. All prepreg should be used as soon as possible using a First-In-First-Out (FIFO) inventory management system. If not handled properly, 185HR prepreg will absorb moisture, which will lead to depressed Tgs and cure and affect flow in the press. If extended storage is required, separate facilities should be reserved with appropriate environmental control. Prepreg should be stored at ≤ 23ºC and below 50% humidity.

Prepreg packages should be allowed to equilibrate to layup room conditions before opening to prevent moisture condensation on the prepreg.

Stabilization time will depend on storage temperature. In cases where storage temperature is significantly below room temperature, keep prepreg in package or plastic wrapping during stabilization period to prevent moisture condensation. Once the original packaging is opened, the prepreg should be used immediately. Remaining prepreg should be resealed in the original packaging with fresh desiccant. Storage should be in the absence of catalytic environments such as high radiation levels or intense ultraviolet light.

Part 2: Innerlayer Preparation

Isola Group's 185HR laminates are fully cured and ready for processing. It has been the experience of most fabricators that stress relief bake cycles are not effective in reducing any movement of high performance laminates such as 185HR. Therefore, it is suggested that the movement of unbaked laminate be characterized and the appropriate artwork compensation factors are used.

Dimensional Stability

The net dimensional movement of laminate after the etch, oxide and lamination processes is typically shrinkage. This shrinkage is due to the relaxation of stresses that were induced when the laminate was pressed as well as shrinkage contribution from the resin system. Most of the movement will be observed in the grain direction of the laminate.

There are situations that have been known to alter the proportion of shrinkage in grain versus fill direction in some board shops. These include autoclave pressing and cross-plying laminate grain direction to that of prepreg. While both of these practices have their advantages, material movement must be uniquely characterized.

Table 1 (for reference) illustrates the suggested approach to characterizing laminate movement and provides *approximate* artwork compensation factors for 185HR laminate when using a hydraulic press.

Table 1: Initial Artwork Compensation Factors

Base Thickness	Configuration	Direction	Comp (in/in)
≤ 0.005″	Signal/Signal	Warp (grain)	0.0007-0.0009
"	"	Fill	0.0001-0.0003
"	Signal/Ground	Warp (grain)	0.0005-0.0007
"	"	Fill	0.0001-0.0003
"	Ground/Ground	Warp (grain)	0.0002-0.0004
"	"	Fill	0.0000-0.0002
0.006-0.009″	Signal/Signal	Warp (grain)	0.0005-0.0007
"	"	Fill	0.0001-0.0003
"	Signal/Ground	Warp (grain)	0.0003-0.0005
"	"	Fill	0.0000-0.0002
"	Ground/Ground	Warp (grain)	0.0000-0.0002
"	"	Fill	0.0000-0.0002
0.010-0.014″	Signal/Signal	Warp (grain)	0.0002-0.0004
"	"	Fill	0.0000-0.0002
"	Signal/Ground	Warp (grain)	0.0001-0.0003
"	"	Fill	0.0000-0.0002
"	Ground/Ground	Warp (grain)	0.0000-0.0002
"	"	Fill	0.0000-0.0002

This table assumes that laminate and prepreg grain directions are oriented along the same dimension. Each shop must characterize material behavior given their particular lamination cycles, border designs and grain orientation of laminate to prepreg. It is also suggested that specific laminate constructions be specified and adhered to so that dimensional variations due to changes in construction are avoided.

Table 1 assumes that signal layers are either half or 1 ounce copper and ground layers are either 1 or 2 ounce copper.

Imaging and Etching

185HR laminates are imaged using standard aqueous dry films and are compatible with both cupric chloride and ammoniacal etchants.

Bond Enhancement

Both reduced oxides and oxide alternative chemistries have been used successfully in fabricating 185HR multilayer boards to date. Users should make sure the oxide or oxide replacement coating exhibits a consistent, uniformly dark color.

If reduced oxides are used, consult the chemical supplier for post oxide baking considerations as excessive baking may lead to lower pink ring resistance. It is generally suggested that post-oxide baking be performed vertically, in racks. Suggest mild bake of oxided innerlayers (15-30 minutes @ 80-100°C).

For conveyorized oxide replacements, an efficient dryer at the end of a conveyorized oxide replacement line should remove all moisture from the innerlayer surface. **However, drying of layers for 30 minutes minimum @ 100°C (212°F) or higher is considered a "best practice", especially for boards to be subjected to "lead-free" processes. Drying in racks is preferred.**

Peel strengths may be slightly lower as compared to FR406 due to the higher modulus properties of the resin system. The use of DSTFoil™ will typically increase the bond strength by approximately 1 to 1.5 lbs as compared to non-DSTFoil copper foil.

If immersion tin adhesion treatments are used, the fabricator should test the coating to verify adequate bond strength is developed with 185HR prepregs.

Part 3: Lamination

Standard Lamination

185HR has a wide range for Heat Ramp Rate (Rate of Rise) with a large flow window. This enables multiple approaches to lamination that will achieve good results. The material rheology behaves in a typical manner, therefore lower heat ramp rates have higher viscosity than high heat ramp rates. Heat ramp rates greater than 3°C/min (5.4°F) have a wider process window without requiring modifications to the press cycle.

The amount of time at cure temperature, and to some extent the actual cure temperature of 185HR, will be determined by the thickness of the multilayer package being produced. Very thick boards will require a longer cure time to assure optimum material performance.

Sequential Lamination

Use a 65 minute cure for sub-assemblies depending on thickness and a **75 minute cure for the final assembly.** This suggestion assumes a final assembly thickness ≥ 0.125″ (3.2 mm).

Removal of 185HR flash should be performed by routing rather than shearing to minimize crazing along the panel edges.

Table 2: 185HR General Lamination Parameters

Vacuum Time	10-20 minutes (no pressure, product on risers)
Curing Temperature	190-200°C (375-390°F) Max Temp 205°C (400°F)
Curing Time	75 minutes (above 190°C (375°F) 65 minutes (above 200°C (392°F) For boards >3.0 mm thick, add 15 min to cure time
Resin Flow Window	100-150°C (210-300°F) Maintain heat ramp in this temperature range.
Heat Ramp	3.0-4.50°C/min (5.5-8°F/min)
Pressure	See **Table 3.**
Pressure Application	-Single Stage Apply pressure after vacuum dwell time. -Dual Stage 50 PSI (3.5 Kg/cm^2) after vacuum dwell time, switch to high pressure ≤ 90°C product temperature.
Pressure Drop	After 30 minutes at cure temperature, reduce pressure to 50 PSI (3.5 Kg/cm^2) in hot press (optional).
Cool Down	Cool to 135-140°C (275-285°F) at 2.8°C/min (5.0°F/min) with 50 PSI (3.5 Kg/cm^2) pressure prior to removing or transferring the load.

Table 3 outlines general suggestions for lamination pressure based on press type used.

Table 3: 185HR Lamination Pressure

Lamination Method	Suggested Pressure Range
Hydraulic Pressing (without vacuum assist)	350-450 PSI 25-32 Kg/cm^2
Hydraulic Pressing (with vacuum assist via vacuum frames or bags)	325-450 PSI 22-32 Kg/cm^2
Hydraulic Pressing (vacuum enclosure)	275-400 PSI 19-28 Kg/cm^2

Heavy copper and hard-to-fill designs. These parameters are a general guideline. As designs get harder to fill adjustments will need to be made to the lamination parameters.

General Guide:

– Increasing Heat Ramp rate helps flow.
– High layer count with many 1 oz or 2 oz layers: Increase pressure
– >3 oz copper: Contact Isola Technical Service

Part 4: Drill

General

The 185HR material has high thermal performance and stability. Due to this high thermal performance, the material tends to form free standing chips during drilling, and is not likely to create drill smear. Due to the increased thermal decomposition temperature of the resin system, the drill debris remains as free particles and will not impact the drill flute relief volumes.

To assure effective removal of the resin debris during drilling, undercut drill geometries and high helix tools are recommended. On high layer count technologies and thicker overall board thicknesses, peck drilling parameters may be necessary. Suggested parameters are outlined below for typical multilayer designs.

Cutting Speed and Chipload

The parameters in **Table 4** provide a *moderate initial starting point for typical board designs.* Thick boards with heavy copper or special cladding such as invar will require more conservative drill parameters.

The drill process has a wide window with good results. Parameters depend on cure quality, design and drill bit type. Drill tip speed varies from 110-170 m/min (360-550 ft/min) and chipload varies from 60-75 micron/rev (2.4-3 mils/rev). Users need to factor in small bit reductions, use ratios from supplied drill chart.

Stack Height and Hit Count

Stack heights and hit counts will vary with the construction and overall thickness of the boards being drilled. Standard 1.6 mm (0.062″) thick boards have been successfully stacked 3 high for bit diameters down to 0.35 mm (13.8 mils). As a general guideline, the sum of the board thickness in a multilayer drill stack should not exceed 5 mm (200 mils). Maximum hit count for a small drill diameter is 1000. For drill diameters of 0.35 mm (13.8 mils) and greater, maximum hit count is 1500.

Part 5: Hole Wall Preparation

General

When 185HR is properly cured and drilled, it will generate very little smear. The main purpose of desmear processing on this material is to remove debris and provide an acceptable texture to the hole walls.

Good desmear and electroless copper deposition performance are more easily achieved when the drilled hole quality is good. The generation of smooth, debris free hole walls is influenced by the degree of resin cure, drilling conditions and board design considerations. The elimination of 7628 or similar heavy glasses (whenever possible), coupled with properly adjusted drill parameters on fully cured boards has been shown to improve overall drilled hole quality. This helps reduce smear generation, which improves desmear performance and can ultimately help to reduce copper wicking.

Factors which influence chemical desmear rates, and therefore the suggestions in this document, include: resin type, chemistry type, bath dwell times, bath temperatures, chemical concentrations in each bath and the *amount of solution transfer through the holes.*

Factors which influence the *amount of solution transfer through the holes* include: hole size, panel thickness, vertical or horizontal process equipment and equipment agitation parameters.

Chemical Desmear

Conventional permanganate desmear systems are effective for removal of 185HR resin from interconnect posts. Dwell times and temperatures typically used for most high performance, high-Tg materials should be satisfactory. Consult the chemical supplier for suggested conditions.

Table 4: Suggested Drilling Parameters For Initial 185HR Setup (Undercut Bits)

Drill Size		Spindle Speed	Surface Speed Per Minute		Infeed		Chipload		Retract	
Mm	Inch	RPM	SMPM	SFPM	Meter min.	Inch min.	mm Rev.	Mil Rev.	Meter min.	Inch min.
0.15	0.0059	78,000	120	37	1.05	42	0.013	0.54	10	400
0.2	0.0079	87,000	180	55	1.2	47	0.014	0.54	15	600
0.25	0.0098	125,000	322	98	1.85	73	0.015	0.58	15	600
0.3	0.0118	125,000	387	118	2.06	81	0.016	0.65	25	1000
0.4	0.0157	100,000	412	126	2.24	88	0.022	0.88	25	1000
0.5	0.0197	80,000	412	126	2.39	94	0.03	1.18	25	1000
0.6	0.0236	66,000	408	124	2.44	96	0.037	1.45	25	1000
0.7	0.0276	58,000	418	128	2.31	91	0.04	1.57	25	1000
0.8	0.0315	51,000	421	128	2.26	89	0.044	1.75	25	1000
1	0.0394	41,000	423	129	2.21	87	0.054	2.12	25	1000
1.27	0.05	32,000	419	128	1.88	74	0.059	2.31	25	1000
1.5	0.0591	27,300	422	129	1.6	63	0.059	2.31	25	1000
1.75	0.0689	23,300	420	128	1.37	54	0.059	2.32	25	1000
2	0.0787	20,200	416	127	1.19	47	0.059	2.33	25	1000

Plasma Desmear

Plasma etching is normally not required for 185HR. It can consistently etch the chemically resistant resin system, and properly run provides good hole wall texturing. It can be used with or without a single permanganate pass (to be determined by each fabricator). **Care must be exercised to avoid excessive resin removal if both plasma and permanganate are employed together.** Plasma processing tends to improve overall hole quality, particularly in thick and/or high aspect ratio boards. Standard plasma gas mixtures and cycles are satisfactory.

Hole Wall Condition Verification

It is recommended that users take test samples for hole wall inspection after drill and deburring and after desmearing. The post drill condition indicates hole cleanliness and hole wall damage. Post desmear indicates desmear effectiveness and resin texturing. SEM pictures of holes cut vertically in half have been effective for executing this verification.

3-Point Etchback

True 3-point "etchback" exposes the innerlayer "post" on *all three sides* for subsequent plating processes. This will require a more robust approach compared to simple desmear, which is designed only to remove resin smear from the vertical surface of the innerlayer interconnect "posts".

Plasma will readily etch back 185HR resin. Standard plasma gas mixtures and process cycles designed for conventional FR-4 epoxy are satisfactory and are suggested for use as initial starting parameters for etchback of 185HR. The practice of following the plasma process with a chemical process is suggested rather than plasma alone to increase hole wall texture and remove plasma ash residues.

If plasma is not available, chemical etchback for 3-point connections can usually be accomplished using a double-pass through the permanganate line. Care must be taken when using a double-pass to minimize copper wicking. Consult the chemical supplier for suggested conditions.

Secondary Drilling

The use of entry and backer material may be necessary during the secondary drilling of larger hole sizes to avoid crazing/fracturing at the hole perimeter. Additionally, sharper plunge point angle geometries may be necessary to avoid crazing around secondary drilled hole perimeters.

Routing and Scoring

Modifications of the final PWB rout fabrication process may be necessary. **Table 5** lists initial starting parameters using chip breaker or diamond cut tool designs. **Note that parameters listed may require further adjustment.**

Table 5: Suggested Routing Parameters for Initial 185HR Setup

Tool Diameter		Spindle Speed	Spindle Travel Speed	
Inch	mm	RPM	Inch min.	Meter min.
0.0620	1.5748	45,000	20	0.508
0.0930	2.3622	35,000	40	1.016
0.1250	3.1750	25,000	50	1.270

Chip breaker or diamond cut tool designs recommended.

For PWB designs requiring scored geometries, the testing of various Tgs and resin content materials has determined that adjustments to the process will be necessary. As the modulus strength of materials increases, the maximum resultant web thickness (dependent on the scored edge depth) must be decreased to avoid excessive fracturing upon breaking away the scored materials.

Individual board designs/stack-ups may require adjustment of score depth geometries. **Thinner web thicknesses are typically required.** This is influenced by layer count, glass types and retained copper in the design.

The customer should contact the scoring equipment and/or bit supplier for application specific suggestions for use with 185HR materials. Your Isola Technical Account Manager may also be able to provide some initial suggestions, but these should be validated through testing by the individual PWB fabricator.

Part 6: Packaging and Storage

185HR finished boards have low moisture sensitivity and good shelf life. However, Isola recommends using best practices in storage and packaging, as noted below, to reduce risk during lead-free assembly.

185HR boards should be dry prior to packaging to ensure the most robust lead-free performance. For some complex, high reliability designs, baking prior to solder mask application can be implemented to ensure maximum floor life in assembly processing. Printed boards made for high temperature assembly from 185HR, which require a long shelf life, the best protection is provided using a Moisture Barrier Bag (MBB) with a Humidity Indicator Card (HIC) and adequate drying desiccant inside the MBB to prevent moisture absorption during shipment and long-term storage.

Upon opening the MBB, the boards should be processed within 168 hours when maximum shop floor conditions are at < 30°C (85°F)/60% RH. MBB bags that are opened for inspection should be resealed immediately to protect the boards from moisture uptake.

Part 7: Health and Safety

Always handle laminate with care. Laminate edges are typically sharp and can cause cuts and scratches if not handled properly. Handling and machining of prepreg and laminate can create dust (see 185HR Material Safety Data Sheet).

Appropriate ventilation is necessary in machining/punching areas. The use of protective masks is suggested to avoid inhaling dust. Gloves, aprons and/or safety glasses are suggested if individuals have frequent or prolonged skin or eye contact with dust.

Isola Group does not use polybromidebiphenyls or polybromide-biphenyloxides as flame retardants in any product. Material Safety Data Sheets are available upon request.

Part 8: Ordering Information

Contact your local sales representative or visit **www.isola-group.com** for further information.

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