250HR 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 extended storage is required, separate facilities should be reserved with appropriate environmental control. Prepreg should be stored at <= 23 ºC 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 250HR 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 250HR. 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.

Each shop must characterize material behavior given their particular lamination cycles, border designs and grain orientation of laminate to prepreg.

Imaging and Etching

250HR 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 250HR 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 250HR prepregs.

Part 3: Lamination

Standard Lamination

The 250HR prepreg materials achieve maximum fluidity at approximately 16.6°C (30°F) lower temperatures as compared to standard FR406 prepregs. Therefore, it is recommended that lamination press cycles with a delay, kick over to a high pressure (kiss cycle) be adjusted accordingly due to the lower melt and maximum fluidity temperatures. Additionally, vacuum assist lamination processes are suggested. Non-vacuum lamination processes should be reviewed by Isola technical service engineers prior to production implementation.

The amount of time at cure temperature, and to some extent the actual cure temperature of 250HR, 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 60 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 250HR flash should be performed by routing rather than shearing to minimize crazing along the panel edges.

Table 1 outlines general suggestions for lamination pressure based on press type used.

Table 1: 250HR Lamination Pressure

Lamination Method	Suggested Pressure Range
Hydraulic Pressing (without vacuum assist)	325-400 PSI 22.9-28.1 Kg/cm^2
Hydraulic Pressing (with vacuum assist via vacuum frames or bags)	275-350 PSI 19.3-24.6 Kg/cm^2
Hydraulic Pressing (vacuum enclosure)	250-325 PSI 17.6-22.9 Kg/cm^2
Autoclave Pressing	150-175 PSI 10.6-12.3 Kg/cm^2

Single-Stage Press Cycle Lamination

This page outlines the suggested lamination parameters for a single-stage lamination cycle. **Note that your Isola Technical Service representative may elect to use a dual-stage cycle for some applications.** Dual-stage cycles that utilize "kiss" pressure during the initial stage of the cycle may improve results in some applications.

The lamination cycle selected will be a function of board stackup, complexity and thickness as well as the lamination presses capability. Note that the following graph is for reference purposes only and may require adjustment depending on the board size, thickness and complexity. **Thicker boards may require additional dwell time at curing temperature to achieve full cure.** See "Standard Lamination" previously discussed.

The cycle includes a pressure reduction step, which facilitates stress relief of the package during the cure step. Further, the cycle assumes that vacuum is maintained throughout the heating cycle and that the book is cooled to a temperature well below the Tg of the material before the press is opened. All three conditions are considered to represent "best practice" conditions during lamination by Isola.

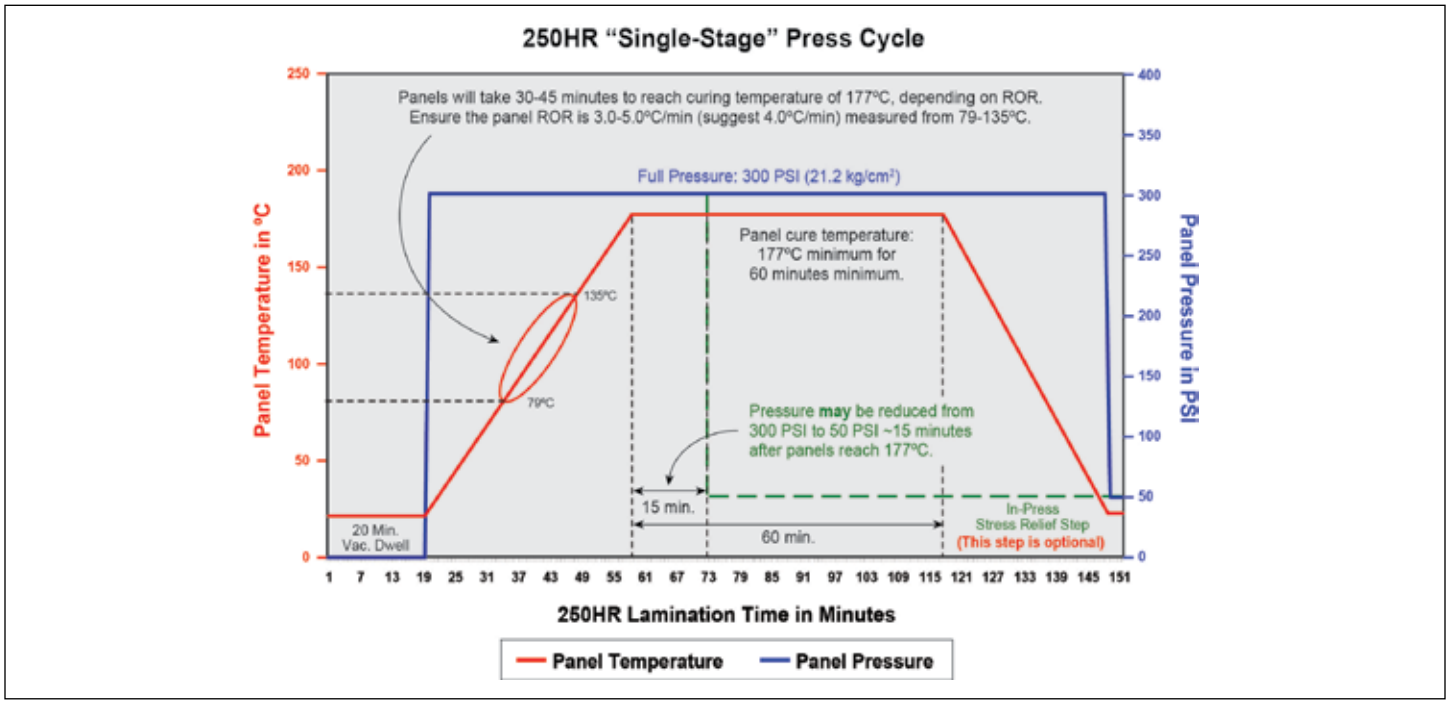
While use of both the pressure drop cycle and cooling well below Tg in the "hot" press are strongly suggested, these steps are considered to be "optional" and the PCB fabricator may have equipment or capacity limitations which prevent following these suggestions.

Single-Stage Lamination (No "Kiss" Cycle)

1. Load/center the package as quickly as possible. **Pull vacuum for 20 minutes on lifters.**
2. Apply pressure of 250-400 PSI (17.5-28.1 kg/cm^2) on the panels. Suggest 300 PSI (21.2 kg/cm^2) initially.
3. Adjust heat rise to ~3.0-5.0°C/min (5.5-9.0°F/min), as measured between 79-135°C (175-275°F) by controlling the platen ramp rate and/or by using the appropriate amount of pressure padding.
   NOTE: If "kiss" pressure is used initially, apply full pressure before exterior panels in the book reach 90°C (194°F). Consult Isola Technical Service for assistance.
4. Cure for a minimum of 60 minutes @ 177°C (350°F) once the package *center* reaches the specified set point. 75 minute cures are appropriate for high layer count boards or thicker boards (above 2 mm)
5. If possible, reduce the pressure to 50 PSI (3.5 kg/cm^2) after package has been at cure temperature for 30 minutes. **This will relieve stress which may assist subsequent thermal processing.**
6. Cool material as slowly as possible or at 3-5°C/min (5.5-9.0°F/min), down from 177°C (350°F) through 125°C (257°F).

Suggested 250HR Single-Stage Pressure-Temperature Profile

Please note: This is not a press control program! The graph represents the preferred pressure/temperature profile *panels* are subjected to during the lamination program cycle. **Note that the actual high pressure setting and cure duration chosen may differ from the 300 PSI suggested setting shown in this graph. Press pressure and cure duration selected may depend upon board design as well as other factors.**



Part 4: Drill

Stack Height and Hit Count

The 250HR materials should be drilled with conventional drill geometries, standard FR4 drilling parameters and standard entry/backup material normally used for high Tg FR-4 materials. In some cases, modifications may be required. To assure effective removal of the resin debris during drilling, undercut drill geometries and high helix tools are suggested for 0.020" or smaller holes. Suggested parameters are outlined in **Table 2** below for typical multilayer designs.

Part 5: Hole Wall Preparation

General

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, work bar stroke length, panel separation in the rack and the use of solution agitation, rack vibration and rack "bumping" to remove air bubbles from the holes.

Prebake

A prebake for 3-4 hours @ 150°C after drilling is suggested before desmearing. **This step is optional.**

Chemical Desmear

Conventional permanganate desmear systems are effective for removal of 250HR resin from interconnect posts. Dwell times and temperatures typically used for most high performance materials should be satisfactory. Consult the chemical supplier for suggested conditions.

Plasma Desmear

If available, plasma can be used with or without a single permanganate pass (to be determined by each fabricator). 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. **Care must be exercised to avoid excessive resin removal if both plasma and permanganate are employed together.**

Table 2: Suggested Drilling Parameters For Initial 250HR Setup

Drill Size		Spindle Speed	Surface Speed Per Minute		Infeed		Chipload	
Inch	mm	RPM	SFPM	SMPM	Inch min.	Meter min.	Mil Rev.	mm Rev.
0.0100	0.2540	100,000	262	79.80	70	1.778	0.70	0.018
0.0150	0.3810	95,000	373	113.71	100	2.540	1.05	0.027
0.0200	0.5080	92,000	482	146.83	100	2.540	1.09	0.028
0.0250	0.6350	84,000	550	167.57	130	3.302	1.55	0.039
0.0300	0.7620	70,000	550	167.57	140	3.556	2.00	0.051
0.0400	1.0160	52,000	545	165.98	155	3.937	2.98	0.076
0.0500	1.2700	42,000	550	167.57	125	3.175	2.98	0.076
0.0600	1.5240	35,000	550	167.57	105	2.667	3.00	0.076

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 250HR 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 250HR. 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

As common with most high Tg epoxy materials with increased modulus properties, 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

Due to the greater modulus properties of 250HR, modifications of the final PWB route fabrication process may be necessary. **Table 3** lists initial starting parameters using chip breaker or diamond cut tool designs. **Note that parameters listed may require further adjustment.**

Table 3: Suggested Routing Parameters for Initial 250HR 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 250HR 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

250HR 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.

250HR 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 250HR, 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 250HR 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 7: Ordering Information

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

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