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G200 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 properties, 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 or damage to the woven glass 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, G200 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 ≤21ºC and below 45% humidity.

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

Long term vacuum storage is not recommended. Prepreg should be maintained to no longer than 3 months at the specified storage conditions. Longer storage should be limited and prepreg must be tested for functionality prior to use.

Stabilization time will depend on storage temperature. In cases where storage temperature is significantly below room temperature, keep prepreg in the original sealed packaging during the 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 G200 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 G200. 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. In the case of high performance laminates, this shrinkage is due to the relaxation of stresses, which were induced when the laminate was pressed, as well as a shrinkage contribution from the high performance 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.

The dimensional movement of high performance laminates is generally greater than that of epoxies. Table I illustrates the recommended approach to characterizing laminate movement and provides approximate artwork compensation factors for G200 laminate when using a hydraulic press.

Table I is for reference only. 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 recommended that specific laminate constructions are specified and adhered to so that dimensional variation due to changes in construction is avoided.

Table 1: G200 Artwork Compensation

Base Thickness	Configuration		Compensation (in/in)
0.005 and Less	Signal / Signal	Warp	0.0008 -0.0012
		Fill	0.0002 -0.0004
	Signal / Ground	Warp	0.0006 -0.0008
		Fill	0.0002 -0.0004
	Ground / Ground	Warp	0.0002 -0.0004
		Fill	0 to 0.0002
0.006 to 0.009	Signal / Signal	Warp	0.0006 -0.0008
		Fill	0.0002 -0.0004
	Signal / Ground	Warp	0.0004 -0.0006
		Fill	0.0001 - 0.0003
	Ground / Ground	Warp	0 - 0.0002
		Fill	0 - 0.0002
0.010 to 0.014	Signal / Signal	Warp	0.0002 -0.0004
		Fill	0 - 0.0002
	Signal / Ground	Warp	0.0001 -0.0003
		Fill	0 - 0.0002
	Ground / Ground	Warp	0 - 0.0002
		Fill	0 - 0.0002

Table I assumes that signal layers are either half or 1 ounce copper and ground layers are either 1 or 2 ounce copper. Thicker copper will generally contribute to greater dimensional movement.

Imaging and Etching

G200 laminates are imaged using standard aqueous dry films and are compatible with both cupric chloride and ammoniacal etchants.

Bond Enhancement

The following bond enhancements are acceptable for adequate bonding of G200 in order of ascending bond strength: post reduced oxides, oxide alternatives and double treat copper. Depending on the oxide used, the bond strength and performance of reduced oxides may depend on the maximum temperature reached when pressing G200. It is recommended that the board temperatures do not exceed 182°C (360°F) when pressing G200 with reduced oxides.

Innerlayers should be thoroughly dried in an oven prior to lay-up. The typical bake cycles that fall between 93°C (200°F) and 121°C (250°F) for 30 to 60 minutes are acceptable for G200. 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 recommended that post oxide baking is performed in vertical racks with panels supported in an upright position.

Package Lay-Up

If the prepreg has been stored such that moisture absorption may have occurred, it should be conditioned prior to lay-up. Dry conditions such as vacuum chambering or the means to reduce residual moisture will improve the flow consistency and realize higher Tg and product properties. Layers should be carefully baked prior to lay-up to eliminate moisture: 30 to 60 minutes at 200°F to 250°F. Layers should be laminated no longer than 4 hours after baking, otherwise store in dry/vacuum environment or rebake.

Part 3: Lamination

Standard Lamination

Standard FR-4 press cycles must be extended in order to fully cure G200 in the press. **Table 2** outlines general suggestions for lamination pressure based on press type used.

Table 2: G200 General Lamination Parameters

Vacuum Time	20 minutes (no pressure, product on risers)
Curing Temperature	180°C (360°F)
Curing Time	90 minutes
Resin Flow Window	90-150°C (195-300°F) Maintain heat ramp in this temperature range.
Heat Ramp	3.5°-5.5°C/min (7.0°-10°F/min)
Pressure	200-300 PSI (14-21 Kg/cm²) Pressure requirements should be assessed for each design."
Pressure Application	Single Stage: – Apply pressure after vacuum dwell time. Dual Stage: – 50 PSI (3.5 Kg/cm²) 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/cm²) in hot press (optional).
Cool Down	Cool to 135-40°C (275-285°F) at 2.8°C/min (5.0°F/min) with 50 PSI (3.5 Kg/cm²) pressure prior to removing or transferring the load.

Removal of G200 flash should be performed by routing rather than shearing to avoid edge delamination.

Part 4: Drill

Cutting Speed & Chipload

Because BT/Epoxy resin blends are more brittle than FR-4 epoxies and more resistant to drill smear due to a higher Tg, successful drilling of G200 will require lower cutting speeds and lower chiploads than FR-4.

Stack Height and Hit Count

Stack height and hit count will depend on overall board thickness and construction. Standard 0.060" thick boards have been successfully drilled stacked 3 high. As a general guideline, the sum of the board thickness in a stack should not exceed 5 mm (200 mils). Maximum hit count for G200 is 750 to 1000, depending on the board design. Re-sharpened bits are not recommended.

Table 3 provides a set of recommended parameters when characterizing the drillability of G200. These parameters are for typical multilayer designs. Boards with particularly heavy cladding such as invar or boards with a lot of coarse glass weave will require more conservative parameters.

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.

Make sure the boards are fully cured and that drilling conditions have been properly adjusted!

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.

Desmear

Permanganate has had only limited success in removing G200 smear in those cases where smear has been present. While many shops do use a permanganate desmear cycle on G200, the benefit may be limited to removal of hole wall debris; only the most aggressive permanganate processes will provide a desmear. Some shops have found that by carefully controlling drill parameters so that smear is eliminated, boards can go directly into the electroless cleaner/conditioner without adverse effects on plating adhesion.

Etchback

Only plasma has been determined to adequately etch back G200 resin. Standard plasma gas mixtures and cycles are satisfactory.

Electroless Coverage

Due to the increased chemical resistance of BT/Epoxy resins, an extended dwell in the electroless cleaner/conditioner bath may be necessary to attain complete electroless coverage and adhesion. Consult the chemical supplier when setting process parameters for G200.

Table 3: Suggested Drilling Parameters for Initial G200 Setup

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.
0.25	0.0098	75,000	59	193	1.52	60	0.020	0.80	15	600
0.30	0.0118	75,000	71	232	1.70	67	0.023	0.89	20	800
0.35	0.0138	73,000	80	263	1.75	69	0.024	0.95	20	800
0.40	0.0157	72,000	90	297	1.83	72	0.025	1.00	25	1000
0.50	0.0197	57,000	90	294	1.45	57	0.025	1.00	25	1000
0.65	0.0256	54,000	110	362	2.03	80	0.038	1.48	25	1000
0.75	0.0295	48,000	113	371	2.16	85	0.045	1.77	25	1000
0.90	0.0354	44,000	124	408	2.24	88	0.051	2.00	25	1000
1.00	0.0394	43,000	135	443	1.09	43	0.025	1.00	25	1000
1.27	0.0500	34,000	136	445	2.16	85	0.064	2.50	25	1000
1.50	0.0591	30,000	141	464	1.83	72	0.061	2.40	25	1000
2.00	0.0787	22,000	138	454	1.40	55	0.064	2.50	25	1000

Part 6: 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 G200 Material Safety Data Sheet (MSDS)).

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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