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, I-Speed prepreg will absorb moisture, which will lead to depressed Tg's 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 I-Speed® 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 I-Speed. 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.

If data already exists for artwork compensation on IS415 or FR408HR material, it is suggested to use those factors for the starting

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point, instead of those listed in Table 1.

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	0.0001-0.0003
"	Ground/Ground	Warp (grain)	0.0001-0.0003
"	"	Fill	0.0000-0.0002

Table 1 (for reference) illustrates the suggested approach to characterizing laminate movement and provides approximate artwork compensation factors.

This table assumes that laminate and prepreg grain directions are oriented along the same dimension. Shrinkage factors differ based on the process and processing equipment used in manufacturing.

Imaging and Etching

I-Speed® laminates are compatible with all industry standard image resists and copper etchants.

Bond Enhancement

Oxide alternative chemistries have been used successfully in fabricating I-Speed multilayer boards to date. They are the only bond enhancement process recommended for lead-free applications. Reduced black oxide is not recommended and is more design and process sensitive, as well as being less thermally stable. Users should make sure the oxide or oxide alternative coating exhibits a consistent and uniformly dark color.

For conveyorized oxide alternatives, the dryer should be capable of removing all moisture from the innerlayer surface. ***However,***
drying of layers for 120 minutes minimum @ 110°C (230°F) or higher is required for boards to be subjected to "Lead-Free" processes. Drying in racks is preferred.

Wet cores interfere with the curing of prepreg, leading to low Tg values and degraded performance. Users need to
verify the effectiveness of their process to achieve dry cores.

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. The use of standard, non-drum side outer layer foil is recommended for all lead-free applications.

Part 3: Lamination

The amount of time at cure temperature and the required pressure will be a function of board design. Thinner boards and copper can run at the lower end of the ranges. Thicker boards may require longer cure times. Heavy copper or designs with significant low pressure areas should use higher pressure.

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Faster heat ramps lower the minimum achieved viscosity and improve resin fill and flow, but require that full pressure application occur before the product reaches the flow temperature. This is helpful with hard to fill product. Slower heat ramps do not achieve the same relative viscosity but have a longer time to fill. They will work better on light copper designs and thinner boards.

Sequential Lamination
Sub-assemblies must be baked prior to performing the secondary lamination. Water will interfere with the curing of the I-Speed resin system.
Sub-assemblies require much longer baking, particularly when stored in open environment.

Baking times range from 3-24 hours at 110-180°C (230-356°F). Extended baking times can be done just before the oxide alternative process. Post alternative oxide bake can be short, just to remove surface moisture. Consult with an Isola Technical Expert for recommendations.

Removal of I-Speed flash should be performed by routing rather than shearing to minimize crazing along the panel edges.

Table 2: I-Speed® General Lamination Parameters

Process	Recommendation
Vacuum Time	20 minutes (no pressure, product on risers)
Curing Temperature	200°C (390°F) 210°C (410°F) Maximum
Curing Time	75 to 105 minutes above 200°C (390°F)
Resin Flow Window	110 to 160°C (230 to 320°F) Maintain heat ramp in this temperature range.
Heat Ramp	3.5 to 5°C/min (6.3 to 9.0°F/min)
Pressure	28 to 35 Kg/cm² (400 to 500 PSI)
Pressure Application	Single Stage: Apply pressure after vacuum dwell time. Dual Stage: 5.5 kg/cm² (75 PSI) after vacuum dwell time, switch to high pressure ≤100°C product temperature.
Pressure Drop	After 30 minutes at cure temperature reduce pressure to 3.5 kg/cm^2(50 PSI) .
Cool Down	Cool to 135 to 140°C (275 to 285°F) at 2.8°C/min (5.5°F/min) with 5.0 kg/cm^2

Part 4: Drill

General

The I-Speed materials exhibit increased thermal stability and generate little or no smear. To assure effective removal of the resin debris during drilling, undercut drill geometries and high helix tools are strongly recommended on drills up to 1.0 mm in diameter. 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. may be necessary.

Cutting Speed and Chipload

Relative to standard FR-4 parameters, use lower chiploads to drill I-Speed printed circuit boards. The parameters in Table 3 provide a moderate initial starting point for typical multilayer board designs.

High cutting speeds and high chiploads are associated with rough holes and fracturing around the glass yarn. Low chiploads have been associated with hole debris and hole wall adhesion issues.

Stack Height and Hit Count

Stack heights and hit counts will vary with the construction and overall thickness of the boards being drilled. For thicker boards, above 2.5 mm (100 mils) overall, with high layer counts, drill one high. Aluminum entry and lubricated backing materials help create good hole wall quality.

Drill Size		Spindle Speed	Surface Speed Per Minute		Infeed		Chipload		Retract	
in	mm	RPM	SFPM	SMPM	in/min	m/min	mil/rev	mm/rev	in/min	mm/min
0.0098	0.25	80,000	206	63	50	1.27	0.63	0.016	600	15
0.0118	0.30	72,000	223	68	60	1.52	0.83	0.021	800	20
0.0138	0.35	70,000	253	77	80	2.03	1.14	0.029	800	20
0.0157	0.40	70,000	289	88	85	2.16	1.21	0.031	1000	25
0.0197	0.50	75,000	387	118	100	2.54	1.33	0.034	1000	25
0.0248	0.63	60,000	390	119	90	2.29	1.50	0.038	1000	25
0.0295	0.75	50,000	387	118	85	2.16	1.70	0.043	1000	25
0.0354	0.90	43,000	399	122	75	1.91	1.74	0.044	1000	25
0.0394	1.00	38,000	392	119	68	1.73	1.79	0.045	1000	25

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0.0500	1.27	32,000	419	128	62	1.57	1.94	0.049	1000	25
0.0591	1.50	28,000	433	132	62	1.42	2.00	0.051	1000	25
0.0787	2.00	22,000	454	138	50	1.27	2.27	0.058	1000	25

Part 5: Hole Wall Preparation

General

When I-Speed® is properly cured and drilled, it 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 reduction or elimination of heavy glasses (whenever possible), coupled with properly adjusted drill parameters has been shown to improve overall drilled hole quality.

Desmear

Two types of desmearing process have been effective on I-Speed.

Plasma etching and chemical desmear combined is the standard process flow for I-Speed. I-Speed requires extended plasma etching cycles. 30-50% more plasma etching amount (weight loss) is required with I-Speed compared with FR408HR.

It is suggested that checking plating quality coupons after plasma etching for positive etchback is helpful to determine best processing parameters. Contact Isola Technical support with questions.

Two passes chemical desmear. I-Speed shows good compatibility with NMP swellers; two passes provides good hole cleaning. Non-NMP swellers are less efficient on I-Speed and should only be used with plasma etching.

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.

A combination of plasma and chemical processing is required. Testing indicates that the plasma provides nearly all of the resin removal. Chemical desmear should be used primarily for hole cleaning and conditioning. Permanganate chemistry alone should not be used for 3-point etchback with I-Speed.

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. Use of the same tool types as primary drilling is recommended. Note that parameters listed may require further adjustment.

Routing and Scoring

Due to the greater modulus properties of the I-Speed materials, modifications of the final PWB rout fabrication process may be necessary. Table 4 lists initial starting parameters using chip breaker or diamond cut tool designs. Note that parameters listed may require further adjustment.

For PWB designs requiring scored geometries, thinner web thicknesses are typically required. Selection of proper web thickness is based on same design factors as other materials.

Table 4: Suggested Routing Parameters for Initial I-Speed® Setup

Tool Diameter		Spindle Speed	Spindle Travel Speed	
in	mm	RPM	in/min	mm/min
0.062	1.57	45,000	20	0.51
0.093	2.36	35,000	40	1.02
0.125		25,000	50	1.27

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Chip breaker or diamond cut tool designs recommended.

Part 6: Packaging and Storage

I-Speed® 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.

I-Speed boards should be dry prior to packaging to ensure the most robust lead-free performance. The use of a Moisture Barrier Bag (MBB) with a Humidity Indicator Card (HIC) and adequate drying desiccant inside the MBB are recommended practices for improving shipping robustness 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 I-Speed 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 8: Ordering Information

Contact your local sales representative or contact: **info@isola-group.com** for further information.

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I-Speed®

Low Loss, Epoxy Laminate and Prepreg

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