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I-Tera® MT40

Very Low-Loss Laminate and Prepreg

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. A First-In-First-Out (FIFO) inventory management system should be used.

If not handled properly, I-Tera® MT40 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 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, do not vacuum seal I-Tera MT40 prepreg. 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-Tera MT40 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-Tera. 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.

able 1: Initial Artwork Compensation Factors

Base Thickness	Configuration	Direction	Comp (in/in)
≤ 0.005″	Signal/Signal	Warp (grain)	0.0007-0.0012
"	"	Fill	0.0007-0.0012
"	Signal/Ground	Warp (grain)	0.0007-0.0012
	"	Fill	0.0003-0.0006
"	Ground/Ground	Warp (grain)	0.0002-0.0004
"	"	Fill	0.0002-0.0004
0.006-0.020″	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

Table 1 (for reference) illustrates the suggested approach to characterizing laminate movement and provides approximate artwork compensation factors for I-Tera MT40 laminate when using a hydraulic press.

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 are 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. Thicker copper will generally contribute to greater dimensional movement in designs where the majority of the copper is removed.

Imaging and Etching

I-Tera® MT40 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 I-Tera MT40 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 inner layers (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 inner layer surface. ***However, drying of layers for 30 minutes minimum @ 100°C or higher is considered a "best practice", especially for boards to be subjected to "lead-free" processes. Drying in racks is preferred.***

If immersion tin adhesion treatments are used, the fabricator should test the coating to verify adequate bond strength is developed with I-Tera MT40 prepregs.

Table 2: I-Tera MT40 General Lamination Parameters

Process	Recommendation
Vacuum Time	Minimum: On Risers 15 min. Product temperature not to exceed 100°C
Curing Temperature	200°C (390°F) Do Not Exceed 210°C Product Temperature
Curing Time	Time at 200°C 60 min.
Resin Flow Window	100-140°C (210-280°F) Maintain heat ramp in this temperature range.
Heat Ramp	3.0-5.0°C/min (5.4-9°F/min)
Pressure	325-375 PSI (23-27 kg/cm^2) ≤ 1oz, ≤ 18 layers 350-400 PSI (25-28 kg/cm^2) >1oz copper, >18 layers
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.
Cool Down	Cool to 135-140°C (275-285°F) at 2.8°C/min (5.0°F/min) with 3.5 kg/cm^2 (50PSI) pressure prior to removing or transferring the load.

Note: Pressure requirements are dependent on product design and technology. Higher pressures have been used on difficult to fill designs.

Part 3: Lamination

Standard Lamination

The amount of time at cure temperature, and to some extent the actual cure temperature of I-Tera MT40, 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 the full cycle for both subassembly as well as final lamination. This suggestion assumes a final assembly thickness ≥ 0.125″ (3.2 mm).

Removal of I-Tera MT40 flash should be performed by routing rather than shearing to minimize crazing along the panel edges.

Part 4: Drill

General

To assure effective removal of the resin debris during drilling, undercut drill geometries and high helix tools are suggested. 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

Relative to standard FR-4 parameters, use lower chiploads and cutting speeds to drill I-Tera® MT40 printed circuit boards. The parameters in Table 3 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. Boards with numerous 2 oz. copper inner layers or boards with coarse glass weave may require more conservative parameters.

Stack Height and Hit Count

Stack heights and hit counts will vary according to 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.

Maximum hit count for drill diameters below 0.020″ is 1,000, while drills at or above 0.020″ diameter can be permitted up to 1,500 hits. These general guidelines are strongly influenced by board thickness, geometry, stack height, etc.

Aluminum entry and lubricated backing help create good quality hole walls but are not essential in all applications. It is suggested that the fabricator’s supplier of entry and backup be consulted.

Table 3: Suggested Drilling Parameters For Initial I-Tera® MT40 Setup

Drill Size		Spindle Speed	Surface Speed Per Minute		Infeed		Chipload		Retract	
inch	mm	RPM	SFPM	SMPM	in/ min.	m/ min.	mil/rev.	mm/rev.	in/min.	m/min.
0.0098	0.25	100,000	258	79	40	1.02	0.40	0.010	600	15
0.0118	0.30	100,000	309	94	80	2.03	0.80	0.020	800	20
0.0138	0.35	95,500	345	105	120	3.05	1.26	0.020	800	20
0.0157	0.40	95,500	394	120	150	3.81	1.57	0.040	1000	25
0.0197	0.50	76,400	394	120	190	4.83	2.49	0.063	1000	25
0.0248	0.63	61,000	396	121	170	4.32	2.79	0.071	1000	25
0.0295	0.75	51,000	394	120	150	3.81	2.94	0.075	1000	25
0.0354	0.90	43,000	399	122	130	3.30	3.02	0.077	1000	25
0.0394	1.00	38,500	397	121	117	2.97	3.04	0.077	1000	25
0.0500	1.27	30,500	399	122	91	2.31	2.98	0.076	1000	25
0.0591	1.50	26,000	402	123	78	1.98	3.00	0.076	1000	25
0.0787	2.00	20,000	412	126	60	1.52	3.00	0.076	1000	25

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.

Chemical Desmear

Trials show that I-Tera MT40 shows good response to chemical desmear. Processing parameters used for 170 Tg FR-4 should be used, excessive dwell time will cause etchback. Two passes of chemical desmear is recommended for high reliability or thicker designs (>2.5 mm). A short plasma etch desmear can be used, comparable to standard FR-4, can be used instead of a second pass chemical desmear.

Plasma Desmear

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 process cycles designed for conventional FR-4 epoxy are suggested for use as initial starting parameters for I-Tera.

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 I-Tera MT40 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 I-Tera MT40. 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. Consult the chemical supplier for suggested conditions.

If plasma is not available, chemical etchback for 3-point connections must be done with extreme care on I-Tera MT40 to minimize copper wicking.

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 route fabrication process may be necessary. Table 4 lists initial starting parameters. Note that parameters listed may require further adjustment.

Table 4: Suggested Routing Parameters for Initial I-Tera® MT40 Setup

Stack Height (Max) Inch	Spindle Speed RPM	Table Speed Inch/min.	Router Bit Life Linear Feet
0.200	25,000	25	35

The customer should contact the scoring equipment and/or bit supplier for application specific suggestions for use with I-Tera MT40 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

I-Tera MT40 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-Tera MT40 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 I-Tera MT40, 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 I-Tera MT40 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 polybromide biphenyls or polybromidebiphenyl oxides 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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NOTES

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