ROGERS CORPORATION

Fabrication Notes

RT/duroid® 6035HTC Series High Frequency Laminates STRIPLINE AND MULTILAYER CIRCUITS Fabrication Guidelines

MATERIAL DESCRIPTION:
RT/duroid® 6035HTC copper clad laminates are thermally conductive filled PTFE composites. In addition to "best in class" heat dissipation capability, RT/duroid 6035HTC substrate materials also provide low dielectric constant and electrical loss characteristics. These guidelines were developed to provide fabricators with basic information on processing double-sided and multilayer boards. A Rogers' technical service engineer or sales representative should be contacted for more detailed processing information.

STORAGE:
Copper clad laminates can be stored indefinitely at ambient conditions. A first-in-first-out (FIFO) inventory system is recommended as is a method of record keeping that would allow tracking of material lot numbers through PWB processing and delivery of finished circuits.

Storage in Original Shipping Cartons
1) Stack cartons on a flat surface that is safely out of the way of mobile handling and moving equipment.
2) Cartons should be stacked to a maximum of five high to avoid excessive weight on the bottom packages.

Storage of Panels Removed from Cartons
1) Thin panels should remain sealed within the polyethylene bags and the adherent polyethylene sheets should remain on thicker cores. These packaging materials deter oxidation and corrosion of the metal layers and provide a measure of protection against mechanical damage (i.e. scratches, pits, dents, etc.).
2) Store panels on edge in slotted shelving units keeping the clad surfaces vertical. This provides easy access with low risk of damage to the metal surfaces.
3) If storage facilities do not permit vertical stacking:
   - A) The shelf must be flat, smooth, and clean.
   - B) The shelf must extend beyond the full area of the panels being stored.
   - C) Surfaces of the laminates must be free of debris.
   - D) Shelf loading should be kept below 50 pounds per square foot.
   - E) Panels should be interleaved with soft, non-abrasive separator sheets.

HANDLING:
PTFE-based materials are softer than most other rigid printed wiring board laminates and are more susceptible to handling damage. Cores clad only with copper foils are easily creased. Materials bonded to thick aluminum, brass, or copper plates are more prone to scratches, pits, and dents. Proper handling procedures should be followed.
1) Wear gloves of knit nylon or other non-absorbent material when handling panels. Normal skin oils are slightly acidic and readily corrode copper surfaces. Fingerprints are difficult to remove as normal brighteners will dissolve the corrosion, but leave corrosive oils in the copper to cause the fingerprint to reappear hours or days later. The following procedure is recommended to remove fingerprints:
   - A) Bright dip in dilute hydrochloric acid.
   - B) Degrease in acetone, methyl ethyl ketone, or vapor degrease with chlorinated solvents.
   - C) Water rinse and bake dry for 60 minutes @ 250°F (125°C).
   - D) Repeat bright dip.
2) Keep work surfaces clean, dry, and completely free of debris.
3) Leave the polyethylene bag or sheet in place through initial processes such as shearing, sawing, blanking, and punching.
4) Only pick panels by two edges. Thin cores in particular lack the stiffness required to support themselves by one edge or corner, handling them in that manner may dimensionally distort the dielectric or impart a permanent crease.
5) During processing, cores should be transported between workstations on flat carrying trays, preferably interleaved with a soft, sulfur-free paper. Vertical racks should not be used unless they are slotted and provide adequate vertical support.

INNER LAYER PREPARATION:
Tooling: RT/duroid 6035HTC is compatible with many tooling systems. Choosing whether to use round or slotted pins, external or internal pinning, standard or multiline tooling, and pre vs. post-etch punching would depend upon the capabilities and preferences of the circuit facility and the final registration requirements. In general, slotted pins, a multiline tooling format, and post-etch punching will meet most needs.

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Whichever approach is used, it is good practice to retain copper around tooling holes.
A flow pattern compatible with the chosen adhesive system can be used between circuits and around the perimeter of the panel. But, in general, registration of layers is improved by retaining as much copper as possible.

Surface Preparation for Photoresist Application: A chemical process consisting of organic cleaners and a microetch is the preferred method of preparing copper surfaces for coating with liquid or film photoresist. A conveyorized spray system using an abrasive substance suspended in solution can be used to prepare copper surfaces at the slight risk of some registration control. Mechanical scrubbing should be considered for thick cores (0.060"+) only and, even then, should be performed at reduced pressures to minimize distorting the thin laminate or imparting deep scratches that change the functional spacing between copper planes.

Photoresist Application: Liquid or dry film photoresist can be applied using traditional dip or spray coating, screening, or roll lamination processes.

DES Processing: Developers, strippers, and copper etchants used to process epoxy glass materials will also work with RT/duroid 6035HTC layers. Thin cores may require leader boards for conveyorized processing and frames or supportive racks for vertical-type processing. The ceramic filled material will require more stringent rinse & bake processing depending upon the next step in the process sequence.

Oxide Treatment: RT/duroid 6035HTC cores are compatible with most oxide and oxide alternative processes. It is best to use the process recommended by the supplier of the adhesive system chosen to bond together the multilayer board. Highly caustic, high temperature processes, such as traditional or reduced black oxides, should be followed by a thorough rinse and bake of the inner layers.

BONDING:
Final Preparation: Special pretreatments of etched surfaces using sodium or plasma processes shouldn't be necessary providing care was taken to protect the substrate surface after copper etch. Inner-layers should be baked at 110°C to 125°C (230°F to 260°F) for 30 to 120 minutes to ensure removal of volatile substances prior to MLB bonding. Guidelines for the oxide treatment should be referenced to make certain the dry bake doesn't degrade the bond-enhancing surface.

Multilayer Adhesive System: RT/duroid 6035HTC cores are compatible with a broad range of thermosetting (FR-4, RO4400™ prepreg, etc…) and thermoplastic (3001 Bonding Film, FEP, PFA, PTFE, etc…) adhesive systems. Many factors, such as electrical performance, flow characteristics, ease of processing, and bond temperature requirements are considered when making the best overall choice. Rogers' Technical Service Engineers (TSE's) understand the trade-offs and, if asked, will help in the selection process.

Multilayer Bond Cycle: The press cycle is determined by the requirements of the chosen adhesive system. Cooling under pressure is required when using thermoplastic (meltable) films.

PTH & OUTER LAYER/DOUBLE-SIDED CIRCUIT PROCESSING:
Drilling: Double-sided boards can be drilled as one-ups or in stack heights that are compatible with the flute length of the drills being used. Phenolic composite boards are recommended for entry (0.010" to 0.030" thick) and exit (>0.060") layers. Sheeted aluminum and metal coated phenolic boards can also be used as entry layers.

New carbide drills are highly recommended. Standard or undercut styles can be used. Recommended chip loads (0.001" to 0.003" per revolution) and surface speeds (150 to 300 SFM) vary with tool diameter with slower infeeds and speeds being associated with finer diameter drills. Retract rate when drilling double-sided constructions between 500 to 1000 IPM. Below is a quick reference table that provides recommended parameters for commonly used drill diameters.

Tool life should be based upon inspection of cross-sectioned holes. The "twelve inch rule," which suggests changing a tool after drilling 12" of substrate, is a good place to start when setting tool life. For example, initial hit count when drilling a 0.060" thick board would be 12"/0.060" = 200 holes.

Tool Size		Spindle Speed	Infeed		Retract	
(in)	(mm)	(RPM)	(IPM)	(m/min)	(IPM)	(m/min)
0.0079	0.20	72500	72.5	1.8	300	7.6
0.0098	0.25	68200	88.7	2.3	300	7.6
0.0138	0.35	55400	83.1	2.1	300	7.6
0.0197	0.50	48200	96.4	2.4	400	10.2
0.0256	0.65	37200	74.2	1.9	400	10.2
0.0295	0.75	32200	64.4	1.6	400	10.2
0.0394	1.00	24100	48.2	1.2	400	10.2
0.0492	1.25	20000	40.0	1.0	400	10.2
0.0625	1.59	20000	40.0	1.0	400	10.2
0.1250	3.18	20000	40.0	1.0	400	10.2

Deburring: The use of flat, rigid entry materials, conservative drilling parameters, and limited hit counts with new drills should minimize the risk of copper burring. When drilled properly, cores should be ready for subsequent processing. If debur is necessary (and slight), a chemical microetch process is preferred. If mechanical processing is required, a hand pumice scrub is preferred over a suspended abrasive spray system which, in turn, is preferred over a conveyorized mechanical debur or planarization process.

Hole Preparation: Loosely deposited debris in the holes can be removed using a vapor or hydro-honing process. These processes involve directing water suspended abrasive particles through drilled holes. The soft laminates must be properly supported through these processes.

Drilled holes in PTFE-based laminates must be treated prior to the deposition of a conductive seed layer (e.g. electroless copper or direct metallization). Not performing a surface activation treatment will most likely result in poor metal adhesion or plated voids. Two common pre-treatments for PTFE materials are sodium treatment and plasma treatment. Either can be used for treating RT/duroid 6035HTC materials.

Sources for sodium treatment chemicals:

FluoroEtch® Etchant

Acton Technologies, Inc,

100 Thompson St, Pittston, PA 18640 - #570-654-0612

W.L. Gore Tetra-Etch® etchant

500 ML available from R.S. Hughes Company, Inc,

1162 Sonora Court, Sunnyvale, CA 94086 #408 739 3211

Sources for sodium treatment services:

FluoroEtch Etchant

Acton Technologies, Inc,

100 Thompson St, Pittston, PA 18640 - #570-654-0612

G & S Associates,

1865 Sampson Ave., Corona, CA 92879,

http://www.gsassociates.com - #951 739 7513

Recommended plasma cycle for treating PTFE materials:

Gases	70/30 or 80/20 H2/N2, NH3, N2, or He
Pressure	100 mTORR pumpdown 50 mTORR operating
Power	4000 Watts
Frequency	40 KHz
Voltage	500-600V
Cycle time	10-30 minutes

Courtesy of Nordson March Plasma Systems

Gases	H2/N2	He	N2
Power	1800W	1800W	1800w
Frequency	13.56 MHz	13.56 MHz	13.56 MHz
Pressure	150 mTor	173 mTor	181 mTor
Gas Mixture (%)	70/30	100	100
Temperature	200°F	200 °F	200°F
Time (minutes)	10 to 20	5 to 10	5 to 10

Courtesy of Plasma Etch Inc.

Panels should be baked for at least 1 hour at 110°C to 125°C (230°F-260°F) prior to plasma treatment. Plasma treated holes are more delicate than sodium etched holes. Panels should not be exposed to any pressure wash or scrubbing process prior to metalization.

*Plasma evaluations were completed using Nordson March Plasma Systems - Series B20 Plasma unit. This unit can process up to 20 - 18" X 24" panels per load. For more information concerning this equipment, please contact Nordson March Plasma Systems (727-573-4567).

Metallization: RT/duroid 6035HTC materials are compatible with traditional electroless copper and direct deposit metallization processes. Cores should be baked 30-90 minutes @ 110°C-125°C (230°F-260°F) prior to metal deposition unless plasma, which also serves as a vacuum bake, was used to prepare the hole walls for plating. A flash plate build-up of 0.0001" to 0.0003" (0.0025mm-0.0076mm) of copper is recommended to better support hole walls through preparation for outer-layer processing.

PTH Plating & Outer-Layer Imaging: Standard equipment and chemical processes are used to plate, image, and etch circuit patterns onto RT/duroid 6035HTC materials. Care should be taken to preserve the post-etch laminate surface. The topography that remains after copper removal promotes improved adhesion to solder masks. Materials should be rinsed and baked prior to solder mask application. Rinsing in warm or hot water for 20-30 minutes followed by 60 minutes @125°C (257°F) should be sufficient, especially if the bake is done under vacuum.

Final Surfaces: RT/duroid 6035HTC materials are compatible with most LPI solder masks. Epoxy solder masks are preferred if the application requires selective silk screening. Most final metal surfaces (ENIG, Sn, Ag, Ni/Au, OSP, etc…) can be applied without special issue or consideration. A bake, as was described prior to solder mask application, should be performed prior to HASL or reflow exposures.

Final Circuitization: Individual circuits can be routed, punched, or lased depending upon preference, tolerances, and edge quality requirements. RT/duroid 6035HTC materials will generally provide a better edge quality than is possible with fiberglass reinforced laminates. Parameters for routing are provided below:

Chip Load	0.00125" to 0.00250"/rev 32mm – 64 mm/rev
Speed	200-300 sfm 61-92 m/min
Peripheries	Conventional cut
Internal cutouts	Climb cut
Tool type	Carbide double fluted spiral-up Endmill
Exit/Entry	Phenolic or composite board
Tool life	20-30 linear feet 6-9 meters

Pre-rout vacuum channels in backer board
Double pass (opposite directions) when cleanest edge quality is required