ROGERS CORPORATION

Fabrication Notes

RO4000® LoPro® Laminates Circuit Processing Guidelines

RO4000® LoPro® laminates combine the excellent attributes of RO4000 substrates with the improved electrical performance of smooth, reverse-treated copper foils. RO4000 LoPro laminates are intended for use in double-sided and, along with RO4400™ bondplies, multi-layered circuit boards.

These guidelines were developed to provide fabricators basic information on processing double-sided and multi-layered printed wiring boards (PWB's) using RO4000 LoPro laminates. Please refer to RO4400 bondply processing guidelines for additional information on inner-layer preparation and multi-layer bonding.

Storage: When stored in accordance with standard best practices for electronic materials, shelf life of the laminates is generally not a concern. A 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.

INNER LAYER PREPARATION:

Tooling: RO4000 LoPro laminates are compatible with many pinned and pinless tooling systems. Choosing whether to use round or slotted pins, external or internal pinning, standard or multi-line 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 multi-line tooling format, and post-etch punching will meet most needs.

Surface Preparation for Photoresist Processing and Copper Etching: The surface resulting from the use of a reverse-treat copper foil makes as-delivered RO4000 LoPro laminates ready to be coated with most liquid and dry film photo resists. However, a chemical process consisting of organic cleaners and/or a microetch can be used to ensure surface cleanliness and improved resolution of etched copper features. Once patterned, RO4000 LoPro laminates are compatible with most develop, etch, and strip systems typically used to process FR-4 materials.

Oxide Treatment: Almost any copper oxide or oxide alternative process can be used to prepare RO4000 LoPro laminates for multi-layer bonding. The best choice is typically the one recommended in the guidelines supporting the chosen prepreg or adhesive system.

Multi-Layer Bonding: RO4000 LoPro laminates are compatible with many thermosetting and thermoplastic adhesive systems. Guidelines for the adhesive system should be consulted for bond cycle parameters.

DRILLING:

DRILLING CONSIDERATIONS: Standard entry (aluminum or thin pressed phenolic) and exit (pressed phenolic or fiber board) materials can be used when drilling RO4000 LoPro laminates in one-up or multi-up stacks. RO4000 LoPro laminates are compatible with a broad range of drilling parameters. However, drilling speeds greater than 500 SFM should be avoided. Chip loads greater than 0.002"/" are recommended for mid-range and large

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diameter tools while lower chiploads (<0.002"/") are recommended for small (<0.0135") diameter drills. In general, standard geometry drills are preferred over undercut styles as they more effectively evacuate debris from the holes during the drilling process. Hit counts should be based upon inspection of plated-through holes (PTH's) and not the appearance of the tools. Drilling RO4000 LoPro laminates will result in an accelerated wear rate of drills. But, hole wall quality is determined by the size distribution of the ceramic powder and not by the cutting edge of the drill bit. A hole wall roughness ranging from 8 to 25 mm is expected and should remain consistent from the initial hit through several thousand hits.

Offered below are a summary of recommended drill parameters, equations for using surface speed and chip load to calculate spindle speeds and infeed rates, and a ready-reference drill table. A Rogers Technical Service Engineer (TSE) should be contacted for more detailed information.

Recommended Ranges:

Surface Speed:	300-500 SFM (90 to 150m/min)
Chip Load:	0.002"-0.004"/rev. (0.05-0.10mm)
Retract Rate:	500 IPM (12.7 m/min) for tools less than 0.0135" (0.343mm), 1000 IPM (25.4 m/min) for all others
Tool Type:	Standard carbide
Tool Life:	2000-3000 hits

CALCULATING SPINDLE SPEED AND INFEED:

Spindle Speed = (12 x Surface Speed (SFM)]/(π x Tool Diam. (in.))

Feed Rate (IPM) = [Spindle Speed (RPM)] x [Chip Load (in/rev.)]

Example:

Desired Surface Speed: 400 SFM

Desired Chip Load: 0.003"(0.08 mm)/rev.

Tool Diameter: 0.0295"(0.75 mm)

Spindle Speed = (12 x 400)/(3.14 X 0.0295) = 51800 RPM

Infeed Rate = 51,800 x 0.003 = 155 IPM

QUICK REFERENCE TABLE:

Tool Diameter	Spindle Speed (kRPM)	Infeed Rate (IPM)
0.0100" (0.254mm)	95.5	190
0.0135" (0.343mm)	70.7	141
0.0160" (0.406mm)	95.5	190
0.0197" (0.500mm)	77.6	190
0.0256" (0.650mm)	60.0	180
0.0258" (0.655mm)	60.0	180
0.0295" (0.749mm)	51.8	155
0.0354" (0.899mm)	43.2	130
0.0394" (1.001mm)	38.8	116
0.0453" (1.151mm)	33.7	101
0.0492"(1.257mm)	31.1	93
0.0531" (1.349mm)	28.8	86
0.0625" (1.588mm)	24.5	74
0.0925" (2.350mm)`	16.5	50
0.1250" (3.175mm)	15.0	45

** Conditions stated are tapered from 200SFM and 0.002" chip load up to 400 SFM and 0.003"chip load.*

PTH PROCESSING:

Surface Preparation: Thick multi-layer and double-sided constructions can be processed through conveyorized debur equipment that uses oscillating nylon brushes to abrade the copper surfaces. Thinner layers may require pumice scrubbing by hand, conveyorized processing with an abrasive spray, or chemical preparation. In general, the thickness of the material and registration requirements should be considered when choosing the best method of debur and surface preparation.

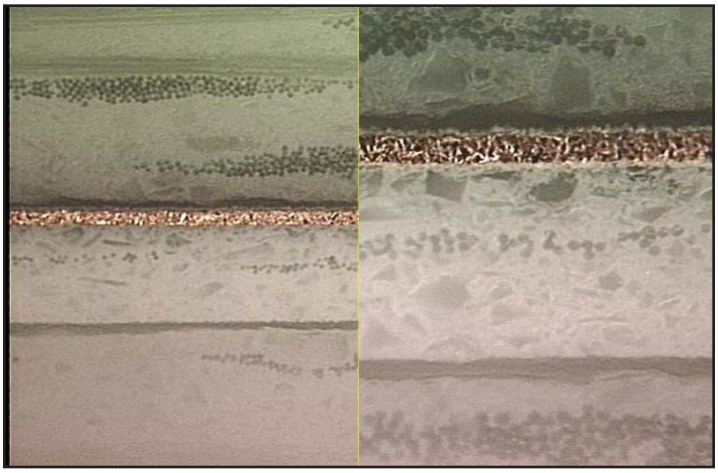
Desmear is typically not required of drilled holes in double-sided boards as the high glass transition temperature of the resin system (>280ºC, >536ºF) minimizes the occurrence of smear. Multi-layer boards may require desmear depending upon the needs of the bondply or prepreg layers. If desmear is required, a single or double pass through alkaline permanganate or a CF4/O2 plasma process may be used. We recommend against etchback of the RO4000 LoPro layers as this might result in aggressive etchback of resin near copper layers and loosening of filler particles on the hole wall.

Metal Deposition:

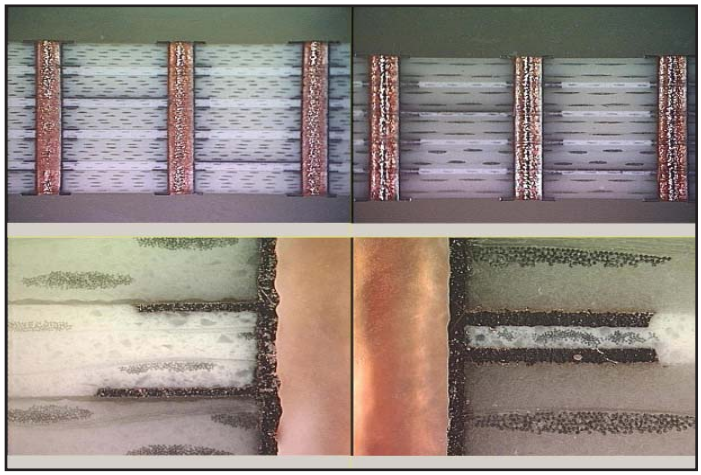
RO4000 LoPro laminates do not require special treatments prior to metallization and are compatible with electroless copper processing and direct deposition of ionic and colloidal conductive layers. A copper flash plate (0.00025") prior to imaging might be considered for boards with high aspect ratio holes.

Visual comparison of RO4000 LoPro laminates and traditional RO4000 cores in multi-layer constructions is provided below. Observe the resin layer that occurs at the core:copper and core:prepreg bondlines.

Expected visual appearance in a cross section of RO4000 LoPro laminates.



Visual comparison of RO4000 LoPro laminates and traditional RO4000 cores in multi-layer constructions.



RO4000 LoPro Cores **Traditional RO4000 Cores**

COPPER PLATING & OUTER-LAYER PROCESSING:

RO4000 LoPro laminates are compatible with panel and pattern processing using standard acid copper and electrolytic tin or tin/lead plating. Once plated, RO4000 laminates can be processed though any standard strip/etch/strip (SES) process.

The post-etch surface of RO4000 LoPro laminates should be preserved as this surface will bond very well with direct screened and photo-imageable solder masks.

Final Metal Finishes:

RO4000 LoPro laminates are compatible with organic solderability preservatives (OSP's), HASL, and most chemically deposited or electroplated finishes.

Warning: RO4003C™, RO4730™, RO4533™, and RO4534™ material do not contain fire retardant(s). We understand boards trapped in an infrared (IR) unit or run at very slow conveyor speeds can reach temperatures well in excess of 700ºF (371ºC). These RO4000 materials may begin to burn at these high temperatures. Facilities which use IR reflow units or other equipment which can reach these high temperatures should take the necessary precautions to assure that there are no hazards.

FINAL CIRCUITIZATION:

Circuits made using RO4000 LoPro laminates can be "individualized " by dicing, sawing, shearing, routing or punching.

V-scoring and breakaway tabs can be used to facilitate individualization of circuits after automated assembly.

Recommendations for routing are provided below:

ROUTING:

RO4000 LoPro laminates are routed using carbide tools and conditions that are typical to processing traditional epoxy/glass materials. Copper should be etched away from the routing path to prevent burring.

MAXIMUM STACK HEIGHT:

The maximum stack height should be based on 70% of the actual flute length to allow for debris removal.

Example:

Flute Length: 0.300" x 0.70 = 0.210"(5.33 mm)

Backer Penetration: – 0.030"(0.762mm)

Max. Stack Height: 0.180"(4.572mm)

TOOL TYPE:

Carbide multi-fluted spiral chip breakers or diamond cut router bits.

ROUTING CONDITIONS:

Surface speeds below 500 SFM should be used whenever possible to maximize tool life. Tool life is generally greater than 30 linear feet when routing the maximum allowable stack height.

Chip Load: 0.0010-0.0015"(0.0254-0.0381mm)/rev

Surface Speed: 300 – SFM

QUICK REFERENCE TABLE:

Tool Diameter	Spindle Speed	Lateral Feed Rate
1/32	40k RPM	50 IPM
1/16	25k RPM	31 IPM
3/32	20k RPM	25 IPM
1/8	15k RPM	19 IPM

***SPECIAL NOTES FOR 0.004" (0.102mm) THICKNESS:**

1) As with all Rogers Laminate Materials, it is recommended fabricators run a first article to establish relevant scaling factors before beginning production of commercial quantities.
2) Bow and Twist: The outgoing inspection criteria for flatness of this construction is <6% Bow and <6% Twist.
3) Electrical Strength: This construction (4 mil dielectric thickness) can be expected to withstand 1,500 volts without experiencing dielectric breakdown.
4) Dimensional Stability: The material shows a negative Dim Stab nominal value of approximately -.5 in both MD and CMD directions, but the variation tends to express slightly more in the negative direction, with the minimum expected value being >-.7 mm/m.
5) Dielectric Constant: The LoPro resin layer is a significant volumetric portion of the overall dielectric, as a result, this material's design dielectric constant will be different than thicker constructions.

Prolonged exposure in an oxidative environment may cause changes to the dielectric properties of hydrocarbon based materials. The rate of change increases at higher temperatures and is highly dependent on the circuit design. Although Rogers' high frequency materials have been used successfully in innumerable applications and reports of oxidation resulting in performance problems are extremely rare, Rogers recommends that the customer evaluate each material and design combination to determine fitness for use over the entire life of the end product.

The information in this data sheet is intended to assist you in designing with Rogers' circuit materials. It is not intended to and does not create any warranties express or implied, including any warranty of merchantability or fitness for a particular purpose or that the results shown on this data sheet will be achieved by a user for a particular purpose. The user should determine the suitability of Rogers' circuit materials for each application.

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