

RO4830™ Laminates

Circuit Processing Guidelines

Introduction: RO4830™ material is a glass reinforced, ceramic filled thermosetting hydrocarbon resin system clad using Rogers' proprietary surface modified (LoPro®) reverse treat copper foil. These guidelines were developed to provide fabricators basic information on processing multi-layered circuit boards using RO4830 laminates.

Intended Use: RO4830 cores are intended for use in automotive radar designs operating in the millimeter wave frequency range. When used as cap layers on hybrid MLBs, the compatibility of 0.005" and 0.0094" thick RO4830 cores with FR-4 materials and FR-4-like processing parameters provide the optimum balance of performance and cost. The glass content of RO4830 cores is kept at a minimum to promote uniform electrical performance. Low glass content can result in an increased risk of bow and twist of inner-layers, especially when copper on opposing sides of a core is not balanced. For this reason, it is recommend to retain as much copper as possible on the layer two side of cap cores.

Storage: RO4830 LoPro laminates can be stored indefinitely at ambient conditions. 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: RO4830 laminates are compatible with many pinned and pinless tooling systems. Choosing whether to use round or slotted pins, external or internal pinning, standard or multilayer 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 multilayer tooling format, and post-etch punching will meet most needs.

Surface Preparation for Photoresist Processing and Copper Etching: A chemical cleaning process that is appropriate for reverse-treat copper foils should be used to prepare RO4830 cores for inner-layer processing. Once through surface preparation, RO4830 materials are compatible with most liquid and dry film photo-resists and can be processed through develop, etch, and strip (DES) systems typically used to process FR-4 materials.

Oxide Treatment: RO4830 cores can be processed though any copper oxide or oxide alternative process in preparation for multi-layer bonding. The best treatment choice is typically the one recommended for use with the chosen prepreg or adhesive system.

Multi-Layer Bonding: RO4830 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: RO4830 cores can be laser processed using UV and/or CO2 lasers. Chemical or plasma desmear may be required to clean the surface of L2 copper features.

Standard entry (aluminum or thin pressed phenolic) and exit (pressed phenolic or fiber board) materials can be used when mechanically drilling RO4830 cores or bonded MLBs in one-up or multi-up stacks.

RO4830 materials 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"/rev are recommended for mid-range and large diameter tools while lower chiploads (<0.002"/rev) 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 RO4830 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 μm 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	300-600 SFM (90 to 150m/min)
Chip Load	0.002"-0.004"/rev. (0.05-0.10mm)
Retract Rate	500 IPM (12.7m/min) for tools less than 0.0135" (0.343mm), 1000 IPM (25.4 m/min) for all others
Tool Type	Standard carbide
Tool Life	2,000-3,000 hits

CALCULATING SPINDLE SPEED AND INFEEED:

Spindle Speed = $(12 \times \text{Surface Speed (SFM)}) / (\pi \times \text{Tool Diam. (in.)})$
 Feed Rate (IPM) = $[\text{Spindle Speed (RPM)}] \times [\text{Chip Load (in/rev.)}]$

Example:

Desired Surface Speed: 400 SFM
 Desired Chip Load: 0.003"(0.08 mm)/rev.
 Tool Diameter: 0.0295"(0.75 mm)
 Spindle Speed = $(12 \times 400) / (3.14 \times 0.0295) = 51800 \text{ RPM}$
 Infeed Rate = $51,800 \times 0.003 = 155 \text{ IPM}$

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
0.0935" (2.350mm)	16.5	50
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: Multi-layer constructions can be processed through conveyerized debur equipment that uses oscillating nylon brushes to abrade the copper surfaces. However, minimum pressure should be applied.

Multi-layer boards will require desmear prior to copper plating. A single pass through alkaline permanganate or a CF₄/O₂ plasma process may be used. Plasma desmear is recommend for CAF sensitive designs.

We recommend against etchback of the RO4000 LoPro layers as this might result in aggressive etchback of resin near copper and glass layers.

Metal Deposition:

RO4830 materials 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.

COPPER PLATING & OUTER-LAYER PROCESSING:

RO4830 laminates are compatible with panel and pattern processing using standard acid copper and electrolytic tin or tin/lead plating. Once plated, RO4830 laminates can be processed though any standard strip/etch/strip (SES) process. The post-etch surface of RO4830 laminates should be preserved as this surface will bond very well with direct screened and photo-imageable solder masks.

Final Metal Finishes:

RO4830 laminates are compatible with organic solderability preservatives (OSP's), HASL, and most chemically deposited or electroplated finishes.

FINAL CIRCUITIZATION:

Circuits made using RO4830 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

SHELF LIFE:

Rogers' High Frequency laminates can be stored for extended durations under ambient room temperatures (55-85°F, 13-30°C) and humidity levels. At room temperature, the dielectric materials are inert to high humidity. However, metal claddings such as copper can be oxidized during exposure to high humidity. (Oxidation on the copper surface can easily be removed in a standard micro-etch process.) In addition, over an extended period (>5 years) the exposed dielectric along edges of the panel may experience detectable levels of oxidation. Accounting for standard tooling hole and trim loss, such trace levels of oxidation would not be expected to extend into the utilized portion of the laminate. Please note however, that as each application is different, Rogers cannot warrant that its products are fit for any particular end use, and, as always, Rogers recommends that the circuit designer and/or the end user test the properties and performance of these materials in each proposed application to determine their fitness for use over the entire product life.

Prolonged exposure in an oxidative environment may cause changes to the dielectric properties of hydrocarbon based materials, such as RO4830 laminate. 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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