ROGERS CORPORATION

Fabrication Notes

AD Series™ High Frequency Laminates
STRIPLINE AND MULTILAYER CIRCUITS

MATERIAL DESCRIPTION:

The AD Series™ of copper clad laminates (AD250C™, AD255C™, AD300D™, and AD350A™) combines the superior thermal properties of a fluoropolymer resin system with selected ceramic fillers and fiberglass reinforcement to yield laminated materials with low loss, low thermal expansion characteristics, and low passive intermodulation (PIM). Stability of PTFE over wide frequency and temperature ranges makes AD Series materials ideal for a variety of microwave and RF applications in telecom infrastructure. The inclusion of micro-dispersed ceramic provides thermal stability to the laminate in the form of lower CTE values and greater phase stability across temperatures.

These guidelines were developed to provide fabricators with basic information on processing double-sided and multi-layer boards using copper clad filled and reinforced PTFE composite materials. A Rogers' technical service engineer or sales representative should be contacted for more detailed processing information.

STORAGE:

AD series cores can be stored indefinitely at ambient conditions. A first-in-first-out (FIFO) inventory system is recommended as 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. Cartons may be stored on their side if nothing heavy is stacked on top.
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. For AD Series laminates, some discoloration of copper surfaces due to oxidation can occur during storage, especially under conditions of elevated temperature and humidity. The oxidation can be removed by chemical exposures (microetch) which are standard to the PCB fabrication process.
2. Panels thicker than 20 mils can be stored 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.

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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.

INNER LAYER PREPARATION:

Tooling:
AD Series materials are 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. 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. Rogers' Technical Service Engineers can assist in determining the appropriate flow pattern for a given design.

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 AD Series material 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:
AD Series 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.

NOTE: Registration can be optimized by introducing lamination tooling holes after oxide treatment and bake.

BONDING:

Bonding 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. These treatments can be used to improve surface wettability of the inner-layers that have sat for several days or have been exposed to any type of mechanical processing, with plasma being the preferred method. Proper conditions and parameters for these treatments are provided in the PTH processing section of these guidelines.

Inner-layers should be baked at 110°C to 125°C (230°F to 260°F) for a minimum of 30 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:

AD Series cores are compatible with a broad range of thermosetting (FR-4, Rogers' 2929 bondply, RO4400™ prepreg, etc…) and thermoplastic (CuClad® 6250 & 6700 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 are available to 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. Multilayers are most commonly drilled in stacks of one. 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 (0.00075" to 0.003" per revolution) and surface speeds (75 to 300 SFM) vary with tool diameter with slower infeeds and lower surface speeds being associated with finer diameter drills. Retract rate when drilling double-sided and multilayer boards should be between 300 and 500. The following is a quick reference table that provides recommended parameters for commonly used drill diameters.

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Tool life should be based upon inspection of cross-sectioned holes. This is especially true when drilling multilayer boards where factors such as adhesive type, inner-layer copper weight, and board thickness all affect the hole quality and tool life. 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 multilayer constructions. For example, initial hit count when drilling a 0.060" thick board would be 12"/0.060" = 200 holes. For a similar board thickness, 500 to 600 hits may be achievable with tools smaller than 0.025 diameter using the parameters in the table below. Peck drilling is recommended for MLBs thicker than 0.030".

Tool Size		Spindle Speed	Infeed		Retract	
(in)	(mm)	(RPM)	(IPM)	(m/min)	(IPM)	(m/min)
0.0079	0.20	36000	27.0	0.69	300	7.6
0.0098	0.25	29200	22.0	0.56	300	7.6
0.0138	0.35	27600	20.7	0.53	300	7.6
0.0197	0.50	24000	18.0	0.46	400	10.2
0.0256	0.65	22300	22.3	0.57	400	10.2
0.0295	0.75	25600	25.6	0.65	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 deburr 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 deburr or planarization process.

Hole Preparation:

Loosely deposited debris in the holes can be removed using clean, high pressure air and/or high pressure water rinse.

PTFE composites are typically not desmeared. However, the adhesive system used to bond multilayer boards may require desmear using a chemical (permanganate) or plasma (CF_4/O_2) process. Neither process will have a significant effect upon the PTFE materials, but should be performed prior to activation of the PTFE surface. If plasma is chosen for desmear, a dual cycle to accomplish desmear of an adhesive system and activation of the PTFE surface is made possible by adding the desmear cycle outlined below to the front end of the treatment cycle described in the treatment portion of this section.

AD Series materials may require a glass etch to reduce the risk of plated nodules.

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Frequency:	40 KHz
Voltage:	500-600V
Power:	4000-5000 Watts
Pre-Heat to 60°C using:	
Gases:	90% 02, 10%N2
Pressure:	250mTORR
Desmear using:	
Gases:	75% O2, 15% CF4, 10%N2
Pressure:	250mTORR
Time:	10-30 minutes

Drilled holes in PTFE-based laminates should be treated prior to the deposition of a conductive seed layer (e.g. electroless copper or direct metallization). Not performing a surface activation treatment can 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 AD Series materials.treating AD Series materials.

Sources for sodium treatment chemicals:

FluoroEtch® Etchant
Acton Technologies, Inc
100 Thompson St
Pittston, PA 18640
570-654-0612
www.actontech.com

W.L. Gore Tetra-Etch® etchant 500 ML available from
R.S. Hughes Company, Inc
1162 Sonora Court
Sunnyvale, CA 94086
408 739 3211
www.rshughes.com

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 to 125°C (230° to 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 metallization.

*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.

Metallization

AD Series 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 AD Series 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.

Final Surfaces:

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 (260°F) should be sufficient, especially if the bake is done under vacuum. Properly prepared AD Series materials are compatible with most LPI solder masks. Epoxy masks are preferred if the application requires selective silk screening.

Most final finishes (HASL, Sn, Ag, Ni/Au, OSP, etc...) have been applied to AD Series materials without issue or special concern. A rinse/bake regimen, if not done as part of a solder mask process, should be done prior to HASL or reflow exposures. When flux is needed, acid fluxes are recommended over solvent fluxes. The HASL or reflow exposure should be performed as soon as possible after the flux has been applied.

Final Circuitization:

Individual circuits can be routed, punched, or lased depending upon preference, tolerances, and edge quality requirements. 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 cut- outs	Climb cut
Tool type	Carbide double fluted spiral-up End mill
Exit/Entry	Phenolic or composite board
Tool life	20-30 linear feet, 6-9 meters

Pre-rout vacuum channels in backer board to provide adequate air flow through the channels during routing. Double pass (opposite directions) when cleanest edge quality is required.

The information in this fabrication guideline is intended to assist you in fabricating 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 fabrication guideline 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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