NF-30

General Processing Guidelines

General Information

NF-30 copper clad laminates are constructed with ceramic-filled PTFE composites without a woven fiber glass fabric. The special ceramic-filled PTFE composite techniques on NF-30 can offer low dielectric loss and minimal signal distortion in microwave application. NF-30 bonds well to smooth low profile copper.

The low dissipation of NF-30 combined with the use of very smooth copper results in optimal insertion losses at higher frequency where skin effect losses play a substantial role.

NF-30 laminates are engineered to provide the excellent dimensional stability under non-woven fiberglass reinforcement. It can cover the typical etch or baking shrinkage.

Storage

NF-30 series laminates can be stored indefinitely at room temperature. At room temperature the dielectric materials of NF-30 are inert to high humidity. However metal claddings such as copper can be oxidized during exposure to high humidity. Generally, these traces of corrosion could be easily removed by pre-exposure cleaning procedures.

Even if the resins and components, we use (PTFE, Ceramic fillers, etc.) will not change or degrade in storage, if exposed to high humidity over 50%RH, proper baking process prior to fabricating PCB process is necessary.

Handling

NF-30 laminates reinforcement and are softer than most other rigid base materials for printed circuit Avoid bending or other mishandling which can lead or micro-cracking the composite. These defects may cause various failures, some of which are believed to be a result of chemical infiltration of the fractures or micro-cracks.
board and are more susceptible to handling damage. As with all laminate materials, especially thin materials, care should be taken to avoid distorting the material during handling.

Avoid mechanical scrubbing
Mechanical scrubbing may stretch and deform the material similar to thin core or flexible substrates. Pinch rollers used in many scrubbers may cause dents particle or brush material are pressed into the surface of the laminates.

Unexpected dimensional changes and adhesion strength failure with PSR or other bonding layers are also expected from mechanical scrubbing. Chemical cleaning preferred for NF-30 laminates.

Do not pick up a panel by one edge
Allowing the material to “flop” may stretch the copper and substrate. Lift the panel by two parallel edges; preferably the two closest dimensionally.

Do not stack panels directly on top of each other
The weight of the panels may emboss any particles or debris on the surface of the panel into adjacent panels. If panels must be stacked, use clean soft slip sheet material between each panel and keep stack height to a minimum. Prevent contaminant deposits on the material or copper.

The use of clean protective gloves and slip sheets will prevent contamination and staining. Keep work surfaces clean, dry, and completely free of debris.

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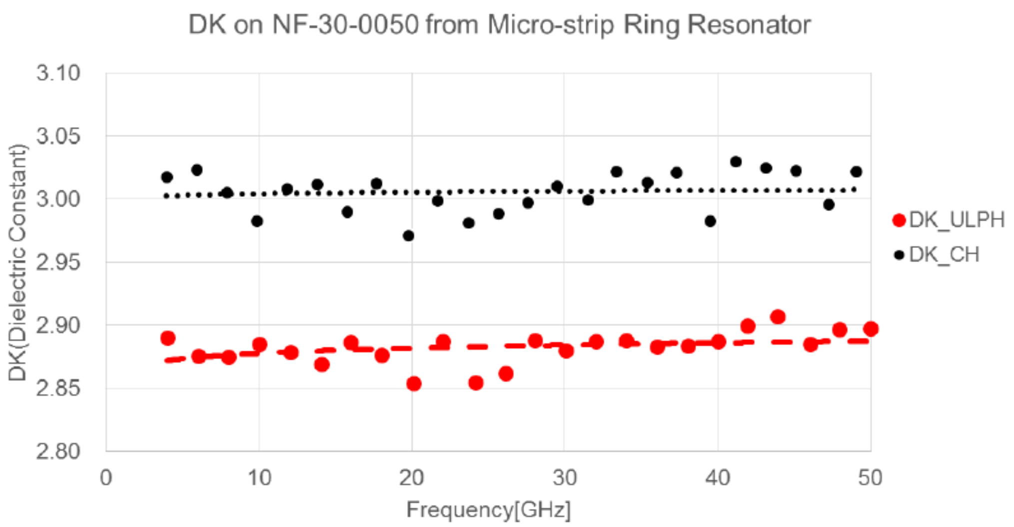
Design consideration

There are many different test methods that can be used to determine a DK value for laminates and the resulting DK values are test method dependent.
Most industrial standard dielectric constant test methods are based on clamped stripline resonator method that apply pressure with clamping between the dielectric substrates and the pattern cards. These test methods have a high degree of repeatability.

The other method can be measured with fabricated PCBs. In this case, results can be affected by a small variation in circuitry pattern length or width, but results can be better matched with actual field test results. Again, there can be different DK results between the clamped stripline resonator method and fabricated microstrip PCB methods regardless of the variation in circuit. These difference can be more than expected for the case of thin dielectric thickness with different profile copper.
Below table show the example of dielectric constant results on NF-30-0050 with different coppers.

Test method	Clamped Stripline		Microstrip Ring Resonator		Remark
DK	**Process DK**		**Design DK**		
Copper	ULPH	CH	ULPH	CH	
Roughness	Rz ≤ 1 µm	Rz ≤ 4 µm	Rz ≤ 1 µm	Rz ≤ 4 µm	
5mil(0.125mm)	3.00	2.99	2.90	3.04	



NF-30 is supplied with ULP copper foil, an Ultra-Low Profile copper foil due to its superior insertion loss at 77 GHz. The slightly lower Design DK is easily adjusted in any CAD program.

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Innerlayer preparation for multilayer

Multilayer applications require that two or more laminates be bonded together to form a single circuit board. There are two important considerations when processing the circuit board. The first is registration of the features from one layer to another. The second is the condition of the bond surface prior to lamination.

Acclimation

If the laminates has been extreme temperatures during shipment or storage, the material should be placed in ambient conditions for 24 hours prior to processing. If exposed to high humidity over 50%RH, proper baking process prior to fabricating PCB process is necessary.

Scaling

This data is for reference only and is dependent on numerous factors such as laminate thickness, copper thickness, copper types, circuit design, adjacent laminates / prepregs, lamination parameters, etc. Most PCB fabricators determine artwork compensation data by running a pilot lot or estimating based on previous experience.
In general, registration of layers can be improved by retaining as much copper as possible.

Property	Condition	MD	CD	Remark
Dimensional stability	After etching	0.018%	0.044%	DT ; 5mil
	After Baking	-0.038%	-0.010%	IPC-TM-650
	After stress	-0.065%	-0.034%	2.4.39.

Surface preparation;

A chemical process consisting of organic cleaners and a micro etch is the preferred method of preparing copper surfaces for coating with photoresist. Mechanical scrubbing is not recommended due to the distorting the thin laminate or imparting deep scratches that change the functional spacing. Both liquid and dry film photoresist can be applied.
NF-30 laminates are compatible with most oxide and oxide alternative processes. 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.
Special pretreatments of etched surfaces using sodium or plasma processes are not generally needed if care was taken to protect the substrate surface after copper etching. Removal of volatile substances prior to MLB bonding should be ensured by proper baking process at 110~125 ℃ for 0.5~2 hours.

Multilayer

For best results, NF-30 laminates should be bonded using low loss bond ply such as fastRise™ series or HB series provided by AGC. The press cycle can be determined by the requirements of the chosen adhesive system of bondply and NF-30 laminates are compatible with most of adhesive systems. Please refer to AGC process guidelines for fastRise.

Drilling

Drill bits

Sharp drill bits are critical to any PTFE drilling; New drill bits should always be used. Undercut drill bits are recommended, but past studies have shown that some drill bit brands may obtain better results using their standard drill bits like new carbide drills.

Chip Load

A nominal chip load of 1.0 mil (25.4 µm) should be used for all tool sizes. Increasing the chip load to 1.25 mils (31.8 µm) may provide acceptable hole quality and improved productivity up to applications.

Cutting speed

Drill speeds of 100 SFM (30.5 m/min) or less is recommended. Slower speeds offer the greatest hole quality improvements. They allow generated heat to dissipate before smearing PTFE. Drill speed can be increased due to equipment limitations but added dwell times may become important. At a simple application, surface speeds of 300 SFM (90 m/min) could also provide acceptable hole quality.

Dwell Time

Low surface speeds will reduce or eliminate the need for dwell. If ideal cutting speeds cannot be obtained, 1,250 ms dwell is recommended for initial process setup in order to cool the drill bit between holes. Past AGC studies have shown that hole wall quality may improve as dwell times are increased to as much as 1,000 ms.

Peck Drilling

Peck drilling should be avoided where possible; it has been shown to increase drill bit wear as well as increase process time. Peck drilling may be required in some situations. If traditional peck drilling is not used, hole-wall quality may be improved with the use of a ”clean” peck where the peck depth is set to equal that of the phenolic entry.

Hit Count

NF-30 laminates can yields exceptional tool life when ideal cutting speeds and chip loads are used. Hit counts of 700~1000 are recommended for initial process setup. Tool life should be based upon cross-section inspections.

Entry materials

Rigid entry and exit material is critical in order to remove any debris or deposits from the drill bit. 10~25 mil (0.25 – 0.6 mm) phenolic entry is acceptable for most applications and 30~50 mil (0.75 -1.0 mm) phenolic entry can be used if pressure foot clearance is substantial.

Backer materials

Like the entry, rigid backer is necessary to prevent burring and aid in obtaining hole-wall quality. Thick phenolic is typical and lubricated rigid backers have also been found to be very successful.

Quick start

The following chart is provided as a general starting point for drill process development. The user shall determine the optimized conditions and suitability.

	Units
Entry Material	Phenolic (0.010”~0.024”/ 0.25~0.6 mm)
Backer Material	Rigid Phenolic, Slickback, or comparable
Cutting Speed	100 ~ 300 SFM (30.5 ~ 91.5 m/min)
Chip Load	0.0010 ~ 0.0015 in (25.4 ~ 38.1 µm)
Dwell	0~1000 ms
Hit Count	700~1200

Drill charts

Following table can be used as general starting point of recommended drilling parameters;

Diameter (mm)	Spindle Speed (krpm)	Infeed (IPM)	Retract (IPM)	Remark
0.2	70	70	300	
0.25	67	70	300	
0.35	55	65	300	
0.5	46	58	400	
0.7	34	46	400	
0.8	30	42	400	
1.0	24	35	400	
1.25	20	30	400	
1.5	20	30	400	
2.5	20	30	400	

PLATING

NF-30 laminates have been engineered to be highly resistant to chemical infiltration and a robust hole wall preparation process is necessary for a successful deposition plating process. Following hole wall preparation, NF-30 will accept standard electroless copper or direct deposit metallization plating process. For high aspect radios or other difficult to plate applications, a second pass through the electroless process may be required to ensure proper hole-wall coverage. It may also be beneficial to run a short duration of electrolyzed copper, rinse etc. then restart the electrolyzed copper from the beginning to expose the hole wall to fresh chemistry.

IMAGE, DEVELOP, ETCH, STRIP

When copper surface preparation is required, chemical cleaning processes are preferred (e.g. microetch); Mechanical scrubbing (e.g. pumice scrub) should be avoided due to possible mechanical damage. Otherwise, standard processing should be used.

SOLDER MASK

No special treatment is required if the surface has not been mechanically scrubbed. In rare cases, where adhesion is poor, a plasma treatment may be used to activate the exposed PTFE.

ROUTING / MILLING

PCBs using NF-30 can be successfully machined using standard router bits or end mills. Rigid phenolic entry and a rigid backer should be used. In some cases, adding paper (white paper or Kraft paper) between the phenolic and the part allows better conformance to surface topography (e.g. circuits, solder mask, etc.) and may reduce burring. For tight tolerances or superior edge quality, a “rough cut” placed 0.005 in. -0.010 in. (0.13 – 0.25 mm) off the part edge may be run prior to the “finish” cut at the nominal part edge. Metallic bits for PTFE board fabrication are recommend. NF-30 materials will generally provide a better edge quality than is possible with the glass reinforced materials.

Following table can be used as general starting point of recommended routing parameters;

Router Diameter		Spindle Speed		Feed Rate
(mils)	(mm)	(kRPM)	(in/min)	(m/min)
33	0.8	50	10.8	0.27
39	1.0	40	12.2	0.31
47	1.2	34	12.6	0.32
63	1.6	25	18.7	0.48
78	2.0	20	27.2	0.69
94	2.4	20	35.0	0.89
118	3.0	20	42.5	1.08
125	3.2	20	43.3	1.10

Hole wall preparation

The debris loosely deposited in the holes can be removed by using a vapor or hydro-honing process. These processes involve directing water suspended abrasive particles through drilled holes. Due to the softness, NF-30 laminates should be properly supported through these processes.

Desmear

Plasma

If panels have been exposed to moisture, bake the boards at 110 ºC for 1 hour. PTFE composites are usually not desmeared but the adhesive system used to bond multilayer require desmear. Standard FR4/epoxy desmear processes should then be used. The desmear plasma time is typically half of that of standard FR4/epoxy times because fastRiseTM resin system tends to etch back very quickly.

Permanganate

Permanganate desmear is not recommended and has been shown to be very aggressive on fastRiseTM resulting in excessive etchback. This is due to the high silica filler content and thermoset content in the resin system. Neither process (Plasma and Permanganate) will have a significant effect on NF-30 materials but should be done prior to activation of PTFE (NF-30) surface.

PTFE Activation

Plasma

If panels have been exposed to moisture, bake the boards at 110 ºC for 1 hour. Plasma treat the PTFE resin using 70%/30% hydrogen/nitrogen gas mixture. 100% helium may also suffice. Power settings for the RF-signal generator are typically 60~75 % of full rated power for 30~60 minutes. Thick panels or high-aspect ratio holes may require extended plasma cycle times. Thick panels may also benefit from an additional 30miutes O2 plasma process prior to the PTFE activation plasma.

Sodium Etch

Sodium Etches (e.g. Fluoroetch) work well. Follow the manufacturer's recommended treatment process. Subsequently, bake for 1 hour at 121 ºC prior to plating to remove moisture that may have been absorbed during the sodium treatment process. Chlorine can have adverse effects on the sodium treatment. Do not subject exposed sodium etch treated holes to heavily concentrated chlorine-based chemical processes.

Process Example

The following table is offered by March Plasma as a basic starting point recipe;

Power(kW)	Pressure(mT)	Gasses	Gas Ratios	Flow(slm)	Pnl Temp (ºC)	Time(min)	Function
4.5	250	O_2 / N_2	90 / 10	2.5	90	A/R	Heating
4	250	CF_4 / O_2	10 / 90	2.5	99	10	Thermoset etch-back
4	250	O_2	100	2.5	99	5	Removes fluorine and cleans others
4.2	250	N_2	100	2.5	99	30	Activate PTFE. H2/N2 Cycle is typically more effective and reliable.

These guidelines can provide only basic and reference information for PCB fabricators. Because of different environment, equipment, tooling and so on, in all instances, the user shall determine suitability in any given conditions or applications. For more detailed processing information, please contact with the AGC engineer or sales representative.

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