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Processing Guidelines

N4000-13 and N4000-13EP

> Note: The following guidelines are provided to assist AGC Nelco laminate and prepreg users with general recommendations for successful processing during PCB fabrication. The recommendations are for general review purposes only and process adjustments may be required to achieve optimum results in your specific manufacturing environment.

High Frequency Low Loss FR-4

Nelco N4000-13 and N4000-13EP are designed for high frequency, low loss requirements, as well as applications with demanding thermal requirements which require a stable Dk through increasing frequencies. When used, the SI version provides enhanced electrical performance.

Material Handling & Storage

Store laminates flat in a dry environment. Do not bend, scratch or dent laminate.
Store prepreg flat, with a storage temperature of <72° F (<23°C) and ≤50% RH.
For extended prepreg storage, reduce storage temperature to <41° F (<5°C).
Reseal opened bags of unused prepreg.

Copper & Surface Preparation

Prepare copper surface for photo resist application according to the following options:
The type of copper surface preparation employed should relate to the foil type as specified below:

- **Reverse Treat Foil (RTFoil®):** Chemical clean followed by a light tack clean.
- **Shiny Copper Foil:** Chemical and / or Mechanical clean followed by a light tack clean.
- **Double Treat Foil:** Chemical clean followed by a light tack clean.

Note: Chemical clean consists of a mild cleaner to remove soils followed by a mild acid to remove the passivation.

Bond Enhancing Treatments

One of the following options can be used successfully:

- Option 1: Brown oxide with DMAB (dimethylamino borane) reduction.
- Option 2: Brown oxide with controlled dissolution post-treatment.
- Option 3: Peroxysulfuric oxide alternative or white (Sn) oxide.

Note: The brown oxide deposit should be tested using a weight loss test. Thick oxide deposits tend to yield poor thermal resistance. The oxide deposit should not exceed 0.4 mg/cm^2.

Inner Layer Drying

Inner layers should be oven dried to remove absorbed moisture. Absorbed moisture in the inner layer can affect the curing properties of the prepreg. Conveyorized warm air drying is usually not effective in removing absorbed moisture from the etched layer.

	U.S. Recommendations	Europe / Asia Recommendations
Signal layers	230°F in vertical racks with minimum 0.5” separation for 30 minutes.	110°C in vertical racks with minimum 1.2 cm separations for 30 minutes
Plane layers and plated sub-lam layers	230ºF in vertical racks with minimum 0.5” separation for 60 minutes	110ºC in vertical racks with minimum 1.2 cm separation for 60 minutes

Note: 1) Check with oxide supplier if using DMAB oxide reducer. Excessive exposure to heat may re-oxidize the reduced treatment.
2) Baking cores in stacks does not provide an effective airflow to remove entrapped moisture from the cores and should be avoided.
3) Drying temperatures below 212F (100°C) are not effective in removing absorbed moisture from the layer.

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Sub-Assembly Baking
Post oxide bake is also recommended for each sub-assembly before relamination. The same recommendations outlined in Inner Layer Drying above should be followed.

Lay-up
For best results, use inner layers within 2 hours after drying. Rebake inner layers if not used within 24 hours.

Lamination
For best results, fully cure in vacuum assisted hydraulic press

	U.S. Recommendations	Europe / Asia Recommendations
Vacuum Gauge Pressure:	A minimum of 28.5" Hg for 15-30 minutes before applying heat & pressure.	A minimum of 965 mbars for 15-30 minutes before applying heat & pressure.
Heat Up Rate*:	4 - 8°F per minute	2 - 4 °C per minute
Critical Range:	180 – 280°F	82 – 138°C
Pressure:	275 - 350 psi	19 - 25 bar
Cure Time, Temp:	90 minutes @ 380 °F	90 minutes @ 193 °C
Cool Down Rate:	7ºF per minute or less until stack reaches 260°F	4°C per minute or less until stack reaches 127°C
Breakdown:	After panels have cooled below 150°F	After panels have cooled below 65 °C

*Note: Heat rise is usually controlled by using an acceptable thermal lagging such as kraft paper or press pads. Alternately the heat rise can be controlled by ramping the platen temperature about 5 – 10 °F (5 °C) higher than book temperatures and controlling the heat up rate through the critical temperature range.

Do not allow product temperature to exceed 201°C (395ºF).

Multiple Sequential Lamination
To reduce stress and embrittlement of the resin system, the following process recommendations can be implemented to aid in the manufacturing of multiple sub-assemblies. Specific adjustments to the normal press cycle should be discussed with your technical representative to ensure optimized results.

Sub-Assembly Build
1) Please consult your technical representative about possibly reducing the sub assembly cure time and/or temperature for your application.
2) Reduce the lamination pressure to 125 psi – 200 psi for the final 30 – 35 minutes of the cycle.
   - Drill smear should not occur; however, hole wall quality should be verified prior to implementation of any new process.
3) In designs where the prepreg layer of a multiple sequential lamination package does not have a critical electrical requirement (Dk/Df), it may be possible to replace this bond ply with a lower modulus material (N4000-7 or N4000-29).

The final lamination cycle should be processed with standard lamination parameters to ensure full cure of the final package.

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Drilling

Typical Drill Parameters	U.S. Recommendations		Europe / Asia Recommendations	
Drill Sizes:	0.010” – 0.018”	0.020” - 0.040”	0.25 – 0.46 mm	0.5 – 1.0 mm
Surface Speed:	300 – 400 SFM	350-450 SFM	91– 122 m/min.	107 – 138 m/min.
Chip Load:	0.5 – 1.5 mils/rev	1.0 – 2.5 mils/rev	12 – 38 µm/rev	25 – 63 µm/rev
Maximum Hit Count:	500 - 1000	750 - 1200	500 - 1000	750 – 1200
Typical Stack Height:	0.045” – 0.100”	0.045” – 0.100”	1.1 – 2.5 mm	1.1 - 2.5 mm

Note: Undercut drills are recommended for small hole drills < 0.0185” (0.47 mm). Peck drilling is recommended for panel thicknesses greater than .100” (2.5mm). Lubricated entry and/or back-up materials may be used to reduce the heat generation during drilling.

Drilling parameters should be adjusted depending on hole size, layer count, panel thickness, copper content and stack height. For specific feed and speed parameters, contact your drill supplier or technical representative. Detailed typical drilling parameters are available for many products at www.agc-nelco.com.

Note: The SI glass is slightly harder and more abrasive than the standard E-glass. Chip loads and drill replacement frequency should be reviewed and revised depending on quantity of SI glass used in the package.

Post Drill Bake

An annealing bake of the drilled panel is recommended for optimal hole wall performance. Panels should be racked & baked in a preheated oven at 356ºF (180ºC) for 2-4 hours. Allow the panels to cool at a rate less than 8ºF/min (4.5ºC/min). In many cases a pre-plasma bake can be used to fulfill this recommendation.

Hole Cleaning (Resin Smear Removal)

Plasma desmear or a plasma desmear followed by a mild permanganate desmear is preferred. Solvent swell and permanganate etch processes can be used but care should be taken to limit the activity and contact times of both solvent and permanganate baths.

Plasma: Typical desmear conditions:

Temperature	Gas mixture	Power	Time
80± 2°C	10% CF_4 , 80% O_2, 10% N_2	4000 W	15-20 min

Note: Depending on the amount of resin removal required, a preheat cycle and an oxygen burn cycle for ash removal may be necessary. Excessive etch-back (> 1.0 mil) of this material is not recommended as it may adversely affect wicking in the hole wall. See your technical representative for additional information.

Chemical Desmear:

Type	Temp (°F)	Temp (°C)	Time
Butyl / hydroxide solvent	173 ± 5	78 ± 2	4 - 6 min.
Alkaline Permanganate oxidizer	175 ± 5	79 ± 2	8 - 12 min.

Note 1: Cyclic amine solvent swellers such as n-methyl pyrolidone (NMP) are not recommended.
Note 2: Control hydroxyl concentration in the permanganate bath below 1.05N (42 g/l for NaOH)

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Routing

Typical Drill Parameters	U.S. Recommendations	Europe / Asia Recommendations
Stack Height:	0.250”	≤6.25 mm
Tool Size:	0.093”	2.4 mm
Feed Rte:	60 IPM	1.5 m/min.
Speed:	24K RPM	24K RPM

Note: When V-scoring please ensure that care is used when removing the break away tabs to avoid damaging the PCB.

The above processing guides are recommendations only and intended for general review purposes. Process adjustments may be required to achieve optimum results in your specific manufacturing environment.

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