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N4000-12 & N4000-12SI

General Processing Guidelines

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High Speed Low Loss Epoxy

N4000-12 and N4000-12 SI® are enhanced epoxy materials designed for use in high speed, low loss applications in the 1-10 GHz range. 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/cm2.

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.

	Recommendations
Signal layers	230°F (110°C) in vertical racks with minimum 0.5” (12 mm) separations for 30 minutes
Plane layers and plated sub-lam layers	230°F (110°C) in vertical racks with minimum 0.5” (12 mm) 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 212°F (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 above in Inner Layer Drying (for plated sub-lam layers) 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

	Recommendations
Vacuum Gauge Pressure	A minimum of 28.5" Hg (965 mbars) for 15-30 minutes before applying heat & pressure.
Heat Up Rate*	4 - 10°F (2 – 5.6 °C) per minute
Critical Range	180 – 280°F (82 – 138°C)
Pressure	225 - 325 psi (15 - 22 bar)
Cure Time, Temp	75 minutes @ 380 °F (75 minutes @ 193 °C) (If boards have a significant amount of internal copper planes then cure time may need to be extended to 90 minutes)
Cool Down Rate	7°F (4°C) per minute or less until stack reaches 260°F (127°C)
Breakdown	After panels have cooled below 130°F (55 °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 (395°F).

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 (ex: N4000-29).

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

Drilling

Typical Drill Parameters	Recommendations	
Drill Sizes	0.010” – 0.020” (0.25 – 0.46 mm)	0.020” - 0.040” (0.5 – 1.0 mm)
Surface Speed	300 – 425 SFM (91– 122 m/min.)	350 - 425 SFM (107 – 138 m/min.)
Chip Load	0.5 – 1.0 mils/rev (12 – 38 µm/rev)	1.0 – 2.0 mils/rev (25 – 63 µm/rev)
Maximum Hit Count	1000 - 1500	1500 – 2500
Typical Stack Height	< 0.100” (< 2.5 mm)	< 0.200” (< 5 mm)

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 AGC’S technical representative. Detailed typical drilling parameters are available for many products. Please contact agc-ml.info-maltimaterial@agc.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 356°F (180°C) for 2-4 hours. Allow the panels to cool at a rate less than 8ºF/min (4.5°C/min). In many cases a pre-plasma bake can be used to fulfill this recommendation.

To reduce crazing in high reliability applications, a post-drill bake of 356°F (180°C) for 2-4 hours is recommended.

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	25-30 min

Note: Depending on the amount of resin removal required, a preheat cycle and an oxygen burn cycle for ash removal may be necessary. See your technical representative for additional information.

Chemical Desmear:

Type	Temp (°F /°C)	Time
Butyl / hydroxide solvent	173 ± 5 / 78 ± 2	4 - 6 min.
Alkaline Permanganate oxidizer	170 ± 5 / 77 ± 2	7 - 10 min.

Note 1: Cyclic amine solvent swellers such as n-methyl pyrolidone (NMP) are not recommended.
Note 2: N4000-12 generally forms less smear than other high Tg epoxy material systems

Routing

Typical Drill Parameters	Recommendations
Stack Height	0.250” (≤6.25 mm)
Tool Size	0.093” (2.4 mm)
Feed Rate	60 IPM (1.5 m/min.)
Speed	24K RPM

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

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.