Fabrication Guidelines for CLTE Products

The Arlon CLTE family of laminate and bonding products is designed to be physically and electrically stable for use in high frequency applications where low loss, dimensional stability, thermal stability of dielectric constant, low water absorption and low Z axis CTE are needed.

CLTE materials used in stripline or microstrip applications can be processed using conventional PTFE board fabrication processes and techniques. CLTE can be processed with few in-line modifications.

Process Guidelines for CLTE Materials

Storage: Store the material flat in a cool dry area away from direct sunlight, avoiding copper oxidation and material contamination.

Bonding: CLTE products can be bonded using a variety of materials, including, Arlon's CuClad® 6700 and 6250 bonding films, Arlon's CLTE-P bonding ply and Arlon's GenClad 280 Prepreg. GenClad 280 Prepreg was introduced to provide a thermoset alternative, capable of sequential lamination. Detailed process information for CLTE-P and GenClad 280 prepreg are incorporated below. See Arlon datasheets or contact Arlon Tech Service for bonding with CuClad® 6700 and 6250 films, as well as for additional properties for GenClad 280.

Adhesion to PTFE surfaces can be enhanced by the use of an inert gas plasma or sodium etch process. It is best to laminate soon after copper etching as possible since the PTFE surface retains the morphology of the copper only for a few hours. When bonding with FR-4, bond to copper is enhanced by use of brown oxide process following an aggressive micro-etch such as ammonium persulate.

Drilling: Drill CLTE materials using highly polished carbide tools. It is not recommended to use repointed tools. Panels can be drilled in stacks base on total thickness. The use of rigid entry (.020" - .030") and exit (.060" - .093") material is recommended. The following feeds and speeds are recommended as a beginning point to develop specific process parameters.

Chip Load: 0.002-0.003 inch/revolution
Surface Speed: 400-450 surface feet/minute
Retract rate: 500-600 inch/minute
Tool life: 500-1000 hits (depending on stack height)

Deburring: Optimization in drilling will eliminate the need for aggressive deburring. If deburring is necessary, properly support the back side of the panel and apply light circular motion with wet 600 grit sandpaper. Use a high pressure spray to remove loose debris in the holes.

Through Hole Preparation: Hole wall resin activation is necessary to ensure coverage with electroless copper deposition. The can be done with plasma or sodium etchants . The following is a typical plasma cycle for PTFE materials:

STEP	GAS MIXTURE	TIME/POWER
Heat-up	80% O_2/20% N_2	To reach 70-90°C material temp
Surface Etch	80% O_2/20% N_2 or 80% O_2/20% O_2	30 minutes @ 75% of full power
O_2 Burn	100% O_2	50% power / 5 min to remove residue

Hold time after plasma may be limited. The plasma process should be repeated if hold time extends beyond 12 hours. Commercially available sodium etchants are commonly used. Contact the following suppliers to obtain the processing guidelines for the products:

Acton Technologies, Inc.	**Product: Fluoroetch**	Phone: 717-654-0612
Matheson Gas Products	**Product: Poly-etch and Poly-Etch W**	Phone: 978-283-7700
W.L. Gore & Associates	**Product: Tetra-etch and Tetra-Prep**	Phone: 800-344-3644

It is important to rinse the CLTE products using an organic solvent and hot water, following the sodium vendor process guidelines. Arlon recommends a bake step to thoroughly dry the product after rinsing. This bake should be performed in a vented oven for 90 minutes at 225° to 250°F (110° - 120°C).

Surface Prep: Standard chemical cleaning techniques are recommended over methods that use mechanical abrasion. Some abrasion techniques - especially those which are machine driven - may cause dimensional change when mechanical shear is applied to the surface of the copper.

Copper Plating: Conventional electroless or direct plate technologies and electrolytic copper chemistries may be used.

Etching: Conventional ammonical or cupric etchants may be used to remove unwanted copper. Rinse thoroughly with warm water after processing.

Resist Strip: Conventional resist strippers may be used to remove unwanted resist.

Soldermask: For SMOBC parts it is recommended that soldermask coating take place within 12 hours after copper etching for best adhesion. To improve soldermask adhesion, sodium or plasma etch will prepare the laminate surface, and a microetch will prepare the copper surface. If required, bake according to the soldermask supplier recommendations.

Hot Air Leveling: Bake CLTE boards for one or two hour at 225° - 250°F (110° - 120°C) prior to solder reflow operations. Vacuum baking is preferred over conventional ovens. Boards should be racked to ensure proper air circulation around the parts to fully remove any residual moisture.

Electroless Gold: It is important to employ adequate rinsing procedures according to the chemical vendor processing guidelines, to ensure reliable process yields for chemical plating.

Routing: It is recommended to use commercially available two-flute, slow spiral, micro-grain carbide, upcut endmills. Support the PTFE product with rigid entry and back-up materials. It is important for the router pressure foot to exert sufficient clamping pressure to the material stack. Typical rout parameters for an 0.062" cutting tool are:

Spindle Speed: 15,000 rpm Table Feed Rate: 15 inches/minute

Multilayer Lamination of CLTE Laminates with CLTE-P Bonding Materials

CLTE-P is a bonding material for use with CLTE family of laminates to manufacture Stripline, Buried Microstrip and other multilayer assemblies. Arlon' s CLTE-P employs a woven fiberglass reinforced, ceramic powder-filled, proprietary resin system to duplicate the mechanical and electrical properties of CLTE products.

Bonding is usually accomplished using one sheet of CLTE-P between the dielectric surface and the copper microstrip. Additional sheets of CLTE-P may be used of required.

Nominal pressed thickness per ply on .003" but effective dielectric spacing will depend on the specific PWB design.

CLTE-P materials used in Stripline or Buried Microstrip applications can be processed after lamination using conventional PTFE and typical FR-4 process parameters with In-line modifications as noted above.

Process Guidelines for CLTE-P Bonding Material

Storage: Store the material flat in a cool dry area away from direct sunlight, avoiding material contamination. Keep bonding material in its original package after opening.

Handling: The material should be handled so as to prevent surface damage an creasing or breaking the woven glass reinforcement. Gloves should be worn to prevent the transfer of contaminants from skin to the bonding material.

Pinning: Clearance holes may be punched, drilled, or cut into bonding material.

Layer Preparation: The inner layer details should be handled in a manner to prevent surface damage, creasing or breaking woven glass reinforcement. Gloves should be worn to prevent the transfer of contaminants from skin to layer material.

It is best to bond immediately after etching. Improved adhesion to the laminate surface can be obtained by using a sodium or plasma etch prior to bonding. Improved adhesion to the copper surface can be obtained by using a micro-etch prior to bonding. Black Or Brown Oxide processes are not recommended due to the high temperatures reached during the bonding process.

Layer material must be clean and dry prior to bonding. To ensure removal of moisture, layer material may be baked in an air-circulating oven for up to one hour at 225-250° F (110-120° C) immediately prior to lay-up. Excess baking may degrade the the material.

Lamination Presses: CLTE-P can be processed in hydraulic or vacuum assisted laminattion presses having the capability to reach 575° F product temperature and to maintain up to 400 psi during the heating, dwell, and cooling cycles.

Bonding is accomplished by raising the product temperature to 560-565° F, when measured by thermocouple at the bond line, holding for 45 minutes, and then cooling below 150 ° F before removing from the press.

Full lamination pressure must be maintained throughout the cycle. Full pressure may range from 400 psi for the hydraulic press to 200 psi for a vacuum-assist press, depending on the specific application.

Process Guidelines for GenClad 280

GenClad 280 Prepreg is a novel bond-ply system comprising both high performance thermoplastic and a thermosetting resin system. It provides electrical performance which is compatible with current PTFE-based composites, offering dielectric constant and loss tangent values similar to laminate systems used by designers of RF, microwave, and high-speed digital devices. It delivers these properties at a process cost similar to traditional printed wiring board materials and methods. GenClad 280 Prepreg is a true enabling technology; it allows the cost effective design, implementation and complete integration of complex circuitry for RF multilayer designs. The following recommendations are starting points; these may require further optimization for design fabrication and equipment considerations.

Prepreg Storage & Handling

GenClad 280 Prepreg is significantly different from earlier generations of low-loss thermoset materials; it is not tacky, brittle or dusty. Store prepreg in a controlled environment, protected from exposure to radiation or ultraviolet light. Storage of the prepreg in its original heat-sealed packaging until use is recommended; the package should be resealed with tape after opening. Prepreg properties will be maintained for twelve months after receipt if stored below 68ºF (<20ºF) and < 50% relative humidity. Prepreg should be allowed to equilibrate at processing room conditions before use and care should be used to prevent moisture condensation. If there is any question about moisture uptake, GenClad 280 Prepreg should be dried at 45-50ºC for 5-10 minutes prior to lamination. This Prepreg should not be stored refrigerated to reduce the chance of moisture condensation.

Lamination

Inner cores should be baked at 225-250ºF for 30 minutes to remove moisture prior to lamination to insure good bond. A pre-vacuum in the press for 30 minutes prior to application of heat or pressure is recommended for removal of air from the package. 350 psi is recommended for lamination of a typical 18”x24” panel. Full pressure should be maintained throughout the cycle. A heat rise of 8-12ºF/minute from 200ºF to 350ºF is recommended to maximize resin flow for circuit filling. A dwell of 90 minutes at 360ºF is necessary to fully cure the resin system to insure electrical and mechanical properties. Depending on the complexity and thickness of the final circuit board, a higher lamination temperature of 375-390ºF may be necessary to ensure full resin cure. Temperatures below 345ºF or cure times below 90 minutes will result in under-cured resin and possible board delamination. A cool-down rate of 10ºF/minute or less is recommended to minimize warping. Be sure to use enough plies of prepreg to encapsulate the thickness of copper traces and patterns. Direct foil lamination for outer layers are possible, but results will vary depending on the specific copper foil used. Contact your Arlon Technical Service representative for specific recommendations.

Drilling

Drilling parameters used with typical PTFE laminate composites have been shown to work well with GenClad 280. Conventional rigid entry and exit materials should be used to minimize copper burrs and optimize hole quality. High quality carbide tipped drill bits are recommended for mechanical hole formation.

Hole cleaning is strongly recommended with all resin systems used on multilayer printed wiring boards to assure reliable interconnection. Hole preparation common for use of PTFE-based circuit board materials is acceptable for use with the GenClad system.

Copper Plating
GenClad 280 Prepreg contains no PTFE and, therefore, requires no special hole treatment to improve wetting of the drilled hole walls. Standard plating processes and several direct metallization systems have been used. To assure the highest standards of plated through reliability, copper plating thickness should be 0.0015” at the center of the plated through hole, for high layer count PWBs.

Metal Finishing
Traditional metal finishes have been used without issue, including reflowed tin-lead, hot air leveled solder, electroless and electrolytic nickel, tin-palladium, tin-silver, immersion tin, and various types of gold plating. A bake at 225-250ºF for 1 hour prior to thermal excursions, such as those encountered during hot air solder leveling, is considered prudent. Bake times and temperatures may require adjustment depending on local conditions.

Printed Wiring Assembly
Standard through hole and surface mount assembly processes are compatible with GenClad. Pre-baking of boards for 1-2 hour bake at 225-250ºF is recommended to reduce the potential for moisture related failures. Fixturing may be required for thin boards or in-panel soldering, due to the lower modulus of GenClad. Assembly methodologies compatible with PTFE boards are appropriate. Special techniques may be required if extensive hand rework and repair is required to avoid pad lifting.

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