CLTE®

Microwave Materials

Dimensionally and Electrically Stable Microwave Printed Circuit Board Substrates

Description:

CLTE® is a ceramic powder-filled and woven microfiberglass reinforced PTFE composite engineered to produce a stable, low water absorption laminate with a nominal dielectric constant of 2.98.

Arlon's proprietary formulation for CLTE materials creates a reduced Z-direction thermal expansion (nearer to the expansion rate for copper metal), improving plated through hole reliability. It is stable during subsequent thermal cycling in process, assembly and use.

The formulation was chosen to minimize the change in ε_r caused by the PTFE 19°C second order phase transition of the molecular structure. This temperature stable ε_r simplifies circuit design and optimizes circuit performance in applications such as phased array antennas.

CLTE also provides higher thermal conductivity which increases the rate of heat dissipation and thus permits use of higher power in an otherwise equivalent design.

CLTE retains the low loss tangent associated with PTFE. While once required only for microwave frequencies, low loss is also of great value in reducing cross talk in high-speed digital applications and minimizes the power of consumption of a circuit design.

Thermoplastic prepreg is available to match the stable electrical and mechanical performance characteristics of CLTE laminates. CLTE-P offers an immediate temperature option for multilayer applications. See page 4 for laminating recommendations.

Availability:

CLTE laminates are supplied with 1/2, 1 or 2 ounce electrodeposited copper on both sides. Other copper weights and rolled copper foil are available. CLTE is available bonded to a heavy metal ground plane. Aluminum, brass or copper plates also provide an integral heat sink and mechanical support to the substrate.

Dielectric constant of CLTE does vary with thickness up to about 0.015. See table below for details.

When ordering CLTE products please specify thickness, cladding, panel size and any other special considerations. Available master sheet sizes include 36" x 48", 36" x 72" and 48" x 54".

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Typical Properties: CLTE® Dimensionally and Electrically Stable Microwave Substrate Materials

Properties	Test Method	Condition	Typical Values
Dielectric Constant @10GHz	IPC TM-650 2.5.5.5	C23/50	2.98
Dissipation Factor @10GHz	IPC TM-650 2.5.5.5	C23/50	0.0025
Thermal Coefficient of E_r (ppm/˚C)	IPC TM-650 2.5.5.5 Adapted	-10˚C to +140˚C	See graph
Peel Strength (lbs per inch)	IPC TM-650 2.4.8	After Thermal Stress	7
Volume Resistivity (MΩ-cm)	IPC TM-650 2.5.17.1	C96/35/90	1.4×10^8
Surface Resistivity (MΩ)	IPC TM-650 2.5.17.1	C96/35/90	1.3×10^6
Arc Resistance (seconds)	ASTM D-495	D48/50	> 180
Tensile Modulus (kpsi)	ASTM D-638	A, 23˚C	471, 462
Tensile Strength (kpsi)	ASTM D-882	A, 23˚C	8.2, 7.0
Compressive Modulus (kpsi)	ASTM D-695	A, 23˚C	225
Flexural Modulus (kpsi)	ASTM D-790	A, 23˚C	375
Dielectric Breakdown (kv)	ASTM D-149	D48/50	> 45
Specific Gravity (g/cm^3)	ASTM D-792 Method A	A, 23˚C	2.38
Water Absorption (%)	MIL-S-13949H 3.7.7 IPC TM-650 2.6.2.2	E1/105 + D24/23	0.04
Coefficient of Thermal Expansion (ppm/°C) X Axis Y Axis Z Axis	IPC TM-650 2.4.24 Mettler 3000 Thermomechanical Analyzer	0°C to 100°C	 10 12 40
Thermal Conductivity (W/mK)	ASTM E-1225	100˚C	0.50
Outgassing Total Mass Loss (%) Collected Volatile Condensable Material (%) Water Vapor Recovered (%) Visible Condensate (±)	NASA SP-R-0022A Maximum 1.00% Maximum 0.10%	 125°C, ≤ 10^{-6} torr	 0.02 0.00 0.00 NO
Flammability (UL File E 80166)	UL 94 Vertical Burn IPC TM-650 2.3.10	C48/23/50, E24/125	UL94V-0

Data based on 0.062" dielectric thickness, exclusive of metal cladding except where indicated by test method. Results listed above are typical properties; they are not to be used as specification limits. The above information creates no expressed or implied warranties. The properties of CLTE-LC laminates may vary depending on the application.

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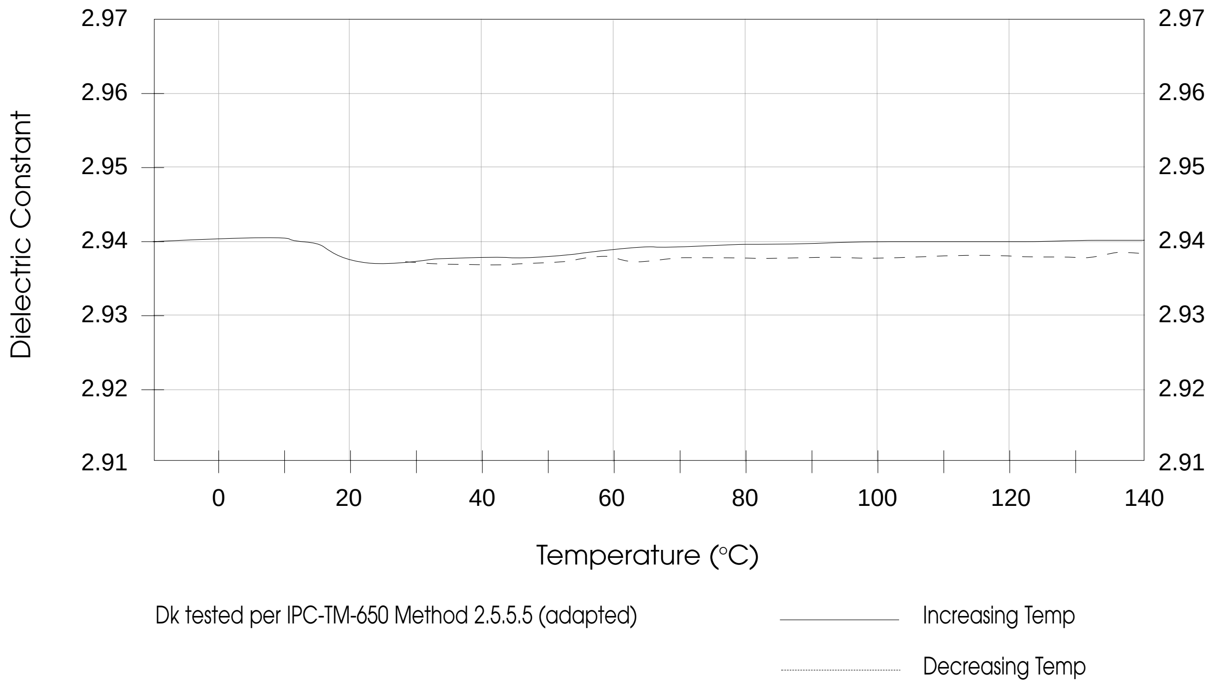
For design purposes it is important to note that both thickness and dielectric constant of CLTE vary with nominal thickness. The following are optimal values to use for design:

Nominal	0.003 ±0.0005	0.005 ±0.0005	0.010 ±0.001	0.015 ±0.0015	0.020 ±0.002	0.031 ±0.002	0.062 ±0.004	0.093 ±0.005
$\bar{x}$ Thickness	0.0031	0.0053	0.0095	0.0155	0.020	0.0304	0.0624	0.0932
Dielectric Constant	2.75 ±.08	2.85 ±.06	2.94 ±.06	2.95 ±.04	2.96 ±.04	2.98 ±.04	2.98 ±.04	2.98 ±.04

For other thicknesses or special orders contact Arlon for thicknesses and dielectric constant values.

Dielectric Constant vs. Temperature



THIS DK/TEMPERATURE CURVE shows the unique thermal stability properties of CLTE materials when thermocycled over temperature. Even over a wide temperature variation, the material retains its ultra-stable dielectric constant characteristics. Because of its low thermal expansion properties, CLTE material is ideal for the fabrication of complex multilayer circuits (see page four for laminating recommendations).

Multilayer Lamination Recommendations

Following the use of conventional imaging and etching processes, successful fabrication of multilayer circuit assemblies using the CLTE Series pre-pregs (designated CLTE-P) with the CLTE series laminates can be achieved through use of the following recommendations.

1. Prepreg Material

The Prepreg material consists of woven fiberglass fabric coated with a proprietary resin formulation. As received, the thickness of pre-preg is ≈ .0032". After lamination, the thickness is compressed to ≈ .0024".

2. Surface Preparation

a. Substrate surface - No additional surface treatment, either mechanical or chemical, should be necessary to achieve good adhesion. However, this recommendation is based upon laboratory conditions where multilayer lamination was performed immediately after etching of the copper surface. For panels which have a long wait time between etching and lamination, a sodium etch (or plasma etch process appropriate for PTFE) of the CLTE laminate surface will provide optimal results.

b. Copper surfaces - Microetch and dry the inner layer copper surfaces immediately prior to lay-up and lamination. Standard FR-4 black oxide processes may not provide optimal results due to the high lamination temperatures required to bond CLTE-P. Brown or red oxide treatments may improve the bond to large copper plane areas.

3. Lamination

a. Equipment - A press which has heat and cool cycles in the same opening is recommended. This ensures that constant pressure can be maintained throughout both the heat-up and cool-down cycle.

b. Temperature - CLTE-P requires a lamination temperature of 550°F/288°C to allow sufficient flow of the resin. The lamination temperature should be measured at the bond line using a thermocouple located in the edge of the product panel.

Because of the high temperatures required for lamination, noncombustible peripheral materials, such as separator sheets and press padding material, should be used. Epoxy separator sheets are not recommended as they may char or burn. Paper and certain rubber press padding materials are also not recommended for similar reasons.

c. Pressure (400 psi actual) - A pressure of 400 psi is recommended to remove any entrapped air and force the flow of the prepreg into the exposed "tooth" present on the surface of the laminate. This pressure must be maintained throughout the full extent of the heating and cooling cycles.

d. Heat up and cool down rate - Since CLTE-P is a thermoplastic material, precise control of heat up and cool down rates is not critical.

e. Time at laminating temperature (45 minutes) - Good adhesion will be achieved by maintaining the recommended laminating temperature for a period of 45 minutes.

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