CLTE

Dimensionally and Electrically Stable Microwave Printed Circuit Board Substrates

CLTE is a ceramic powder-filled and woven micro fiberglass 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 εr caused by the 19°C second-order phase transition in the molecular structure. This temperature stable εr simplifies circuit design and optimizes circuit performance in applications such as phased array antennas.

CLTE also provides higher thermal conductivity that 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.

Features:

- Ceramic/PTFE Composite
- Low Water Absorption
- High Thermal Conductivity
- Low Loss
- Tight Dk and Thickness Tolerance

Benefits:

- Thermally Stable DK and Df
- Dimensional Stability

Typical Applications:

- Radar Manifolds
- Phased Array Antennas
- Microwave Feed Networks
- Phase Sensitive Electronic Structures
- PAs, LNAs, LNBs
- Satellite & Space Electronics

Typical Properties:

CLTE

Property	Units	Value	Test Method
1. Electrical Properties			
Dielectric Constant (may vary by thickness)			
@1 MHz	-	2.98	IPC TM-650 2.5.5.3
@ 10 GHz	-	2.98	IPC TM-650 2.5.5.5
Dissipation Factor			
@ 1 MHz	-	0.0015	IPC TM-650 2.5.5.3
@ 10 GHz	-	0.0023	IPC TM-650 2.5.5.5
Temperature Coefficient of Dielectric	-		
TCεr @ 10 GHz (-40-150°C)	ppm/°C	-9	IPC TM-650 2.5.5.5
Volume Resistivity			
C96/35/90	MΩ-cm	1.40×10^9	IPC TM-650 2.5.17.1
E24/125	MΩ-cm	2.25×10^8	IPC TM-650 2.5.17.1
Surface Resistivity			
C96/35/90	MΩ	1.30×10^6	IPC TM-650 2.5.17.1
E24/125	MΩ	7.52×10^7	IPC TM-650 2.5.17.1
Electrical Strength	Volts/mil (kV/mm)	1100 (43)	IPC TM-650 2.5.6.2
Dielectric Breakdown	kV	64	IPC TM-650 2.5.6
Arc Resistance	sec	245	IPC TM-650 2.5.1
2. Thermal Properties			
Decomposition Temperature (Td)			
Initial	°C	493	IPC TM-650 2.4.24.6
5%	°C	525	IPC TM-650 2.4.24.6
T260	min	>60	IPC TM-650 2.4.24.1
T288	min	>60	IPC TM-650 2.4.24.1
T300	min	>60	IPC TM-650 2.4.24.1
Thermal Expansion, CTE (x,y) 50-150°C	ppm/°C	10, 12	IPC TM-650 2.4.41
Thermal Expansion, CTE (z) 50-150°C	ppm/°C	34	IPC TM-650 2.4.24
% z-axis Expansion (50-260°C)	%	1.5	IPC TM-650 2.4.24
3. Mechanical Properties			
Peel Strength to Copper (1 oz/35 micron)			
After Thermal Stress	lb/in (N/mm)	7 (1.2)	IPC TM-650 2.4.8
At Elevated Temperatures (150°)	lb/in (N/mm)	7.4 (1.3)	IPC TM-650 2.4.8.2
After Process Solutions	lb/in (N/mm)	7 (1.2)	IPC TM-650 2.4.8
Young's Modulus	kpsi (MPa)	1050 (7240)	IPC TM-650 2.4.18.3
Flexural Strength (Machine/Cross)	kpsi (MPa)	19.1/17.4 (132/120)	IPC TM-650 2.4.4
Tensile Strength (Machine/Cross)	kpsi (MPa)	8.2/7 (57/48)	IPC TM-650 2.4.18.3
Compressive Modulus (Machine/Cross)	kpsi (MPa)	225 (1551)	ASTM-D-3410
Poisson's Ratio (Machine/Cross)	-	0.13	ASTM D-3039
4. Physical Properties			
Water Absorption	%	0.04	IPC TM-650 2.6.2.1
Density, ambient 23°C	g/cm^3	2.38	ASTM D792 Method A
Thermal Conductivity	W/mK	0.50	ASTM E1461
Flammability	class	V-0	UL-94
NASA Outgassing, 125°C, $\leq 10^{-6}$ torr			
Total Mass Loss	%	0.02	NASA SP-R-0022A
Collected Volatiles	%	0.00	NASA SP-R-0022A
Water Vapor Recovered	%	0.00	NASA SP-R-0022A

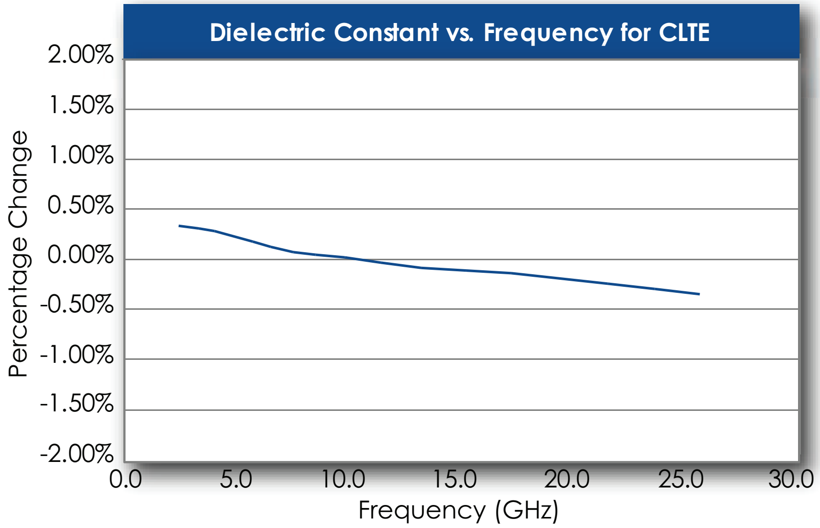

Figure 1
Demonstrates the Stability of Dielectric Constant across Frequency. This information was correlated from data generated by using a free space and circular resonator cavity. This characteristic demonstrates the inherent robustness of Arlon Laminates across Frequency, thus simplifying the final design process when working across EM spectrum. The stability of the Dielectric Constant of CLTE over frequency ensures easy design transition and scalability of design.

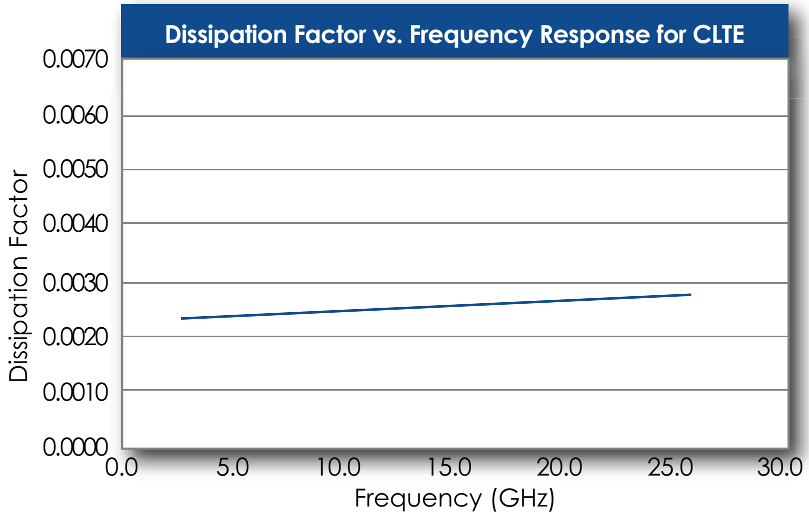

Figure 2
Demonstrates the Stability of Dissipation Factor across Frequency. This characteristic demonstrates the inherent robustness of Arlon Laminates across Frequency, providing a stable platform for high frequency applications where signal integrity is critical to the overall performance of the application.

Material 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 on pg. 4 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", and 48" x 54".

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

Nominal Thickness (mils)	0.003 ±0.0005	0.0053 ±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
Actual Thickness (mils)	0.0031	0.0053	0.0095	0.0155	0.020	0.0304	0.0624	0.0932
Dielectric Constant	2.75 ±0.08	2.85 ±0.06	2.94 ±0.06	2.95 ±0.04	2.96 ±0.04	2.98 ±0.04	2.98 ±0.04	2.98 ±0.04

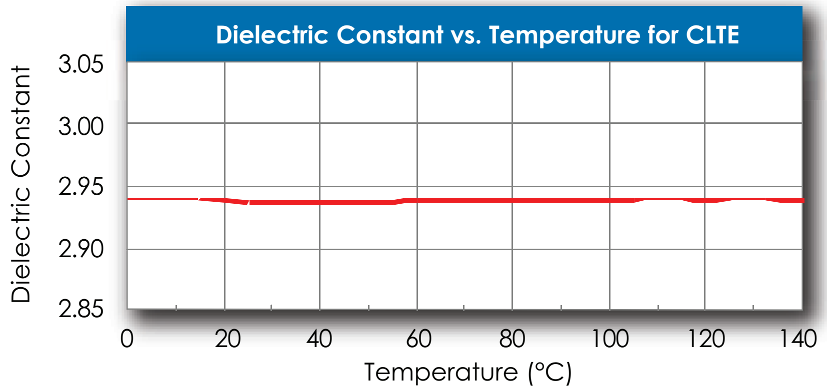

Figure 3
Er/Temperature Curve shows the unique thermal stability properties of CLTE materials over temperature. Even over a wide temperature variation , the material retains its ultra-stable dielectricconstant characteristics.

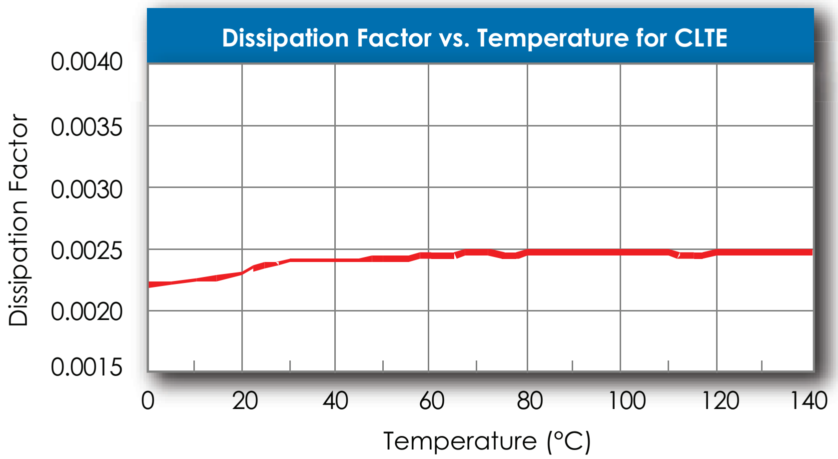

Figure 4
DF/Temperature Curve shows the unique thermal stability properties of CLTE materials over temperature.

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-AT series laminates can be achieved through use of the following recommendations.

Prepreg Material (CLTE-P)

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

Surface Preparation

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-XT laminate surface will provide optimal results.

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.

Lamination

CLTE-P requires a lamination temperature of 565°F/296°C to allow sufficient flow of resin. It is not recommended for bonding layers involving more than ½ ounce copper. Press cycle optimization should be done on each design to insure adequate fill/flow. Starting point guidelines are listed below. Contact your Arlon representative with specific questions.

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.

Temperature - CLTE-P requires a lamination temperature of 550°F/572°F (288-300°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.

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.

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.

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