ARLON
MICROWAVE MATERIALS

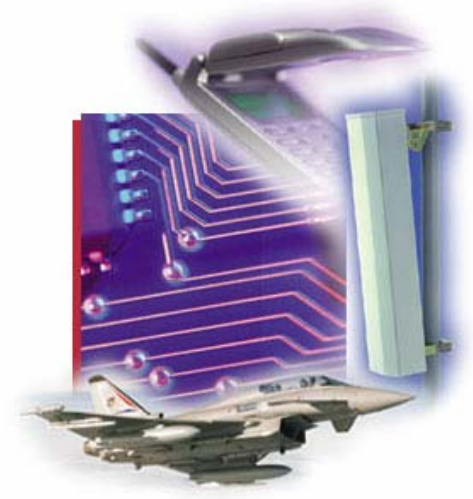
CLTE®

Dimensionally and Electrically Stable Microwave Printed Circuit Board Substrates

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



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.

Typical Properties: CLTE			
Property	**Test Method**	**Condition**	**Result**
Dielectric Constant @ 10 GHz	IPC TM-650 2.5.5.5	C23/50	2.98
Dissipation Factor @ 10 GHz	IPC TM-650 2.5.5.5	C23/50	0.0025
Thermal Coefficient of Er	IPC TM-650 2.5.5.5 Adapted	-10°C to +140°C	See Figure 3
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^{9}
Surface Receptivity (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	ASTM D-149	D48/50	>45
Density (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 34
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%	$125° \leq 10^{-6}$ 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

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", 36" x 72" and 48" x 54".

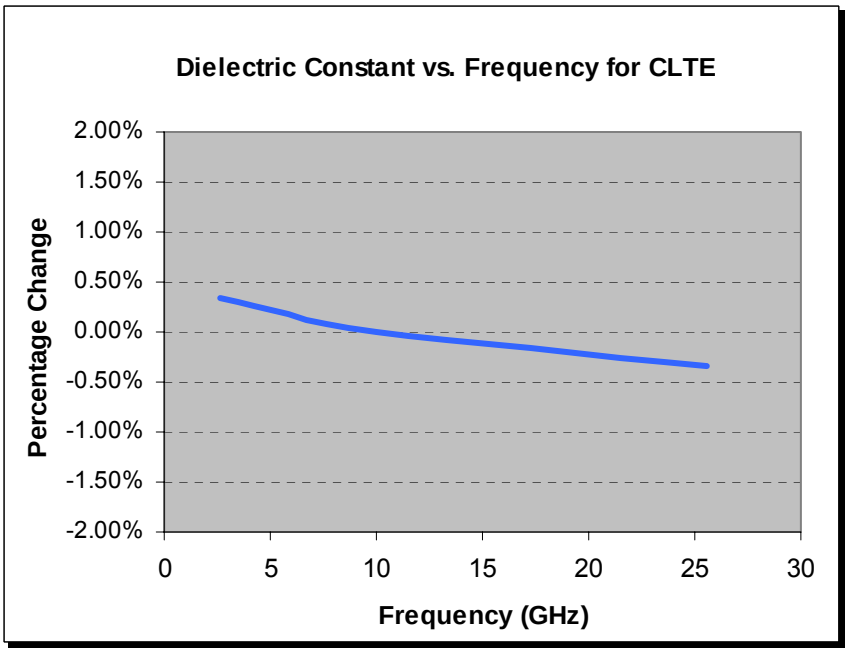


Figure 1

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.

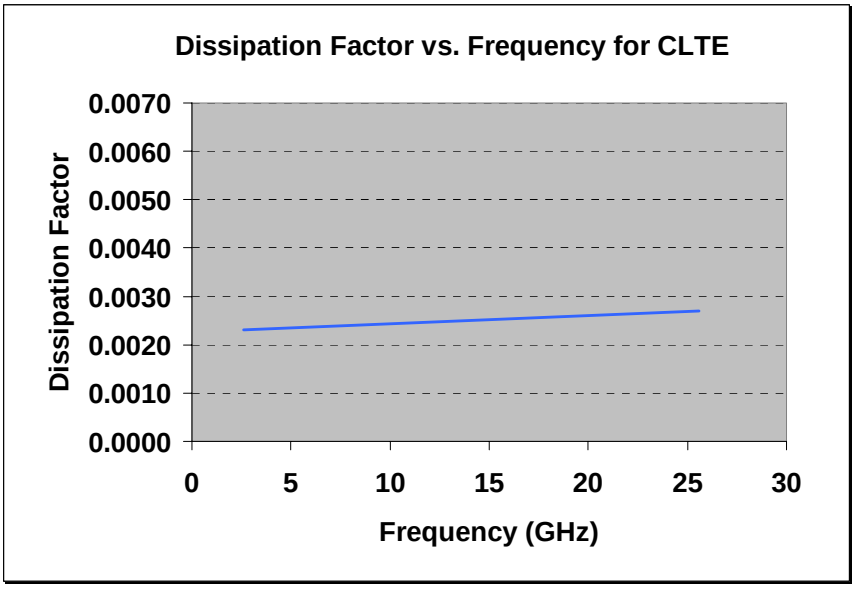


Figure 2

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.

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	0.005 ±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
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

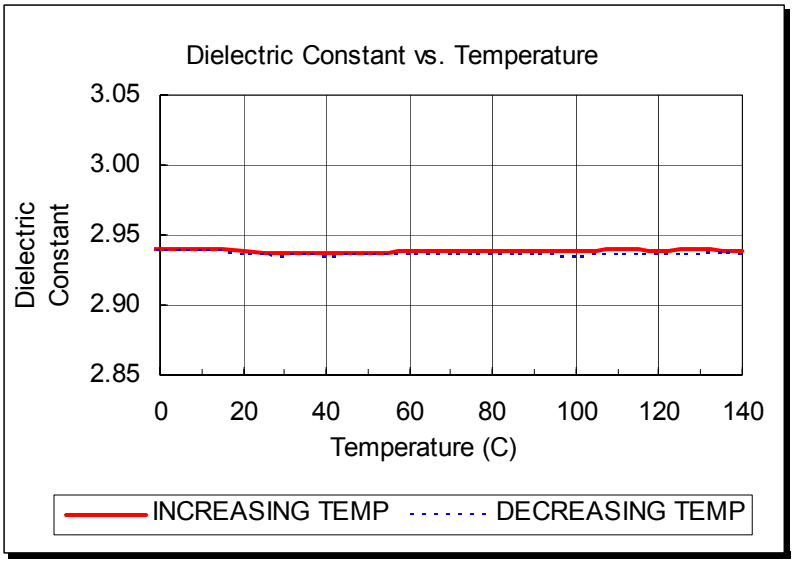


FIGURE 3

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 dielectric constant characteristics.

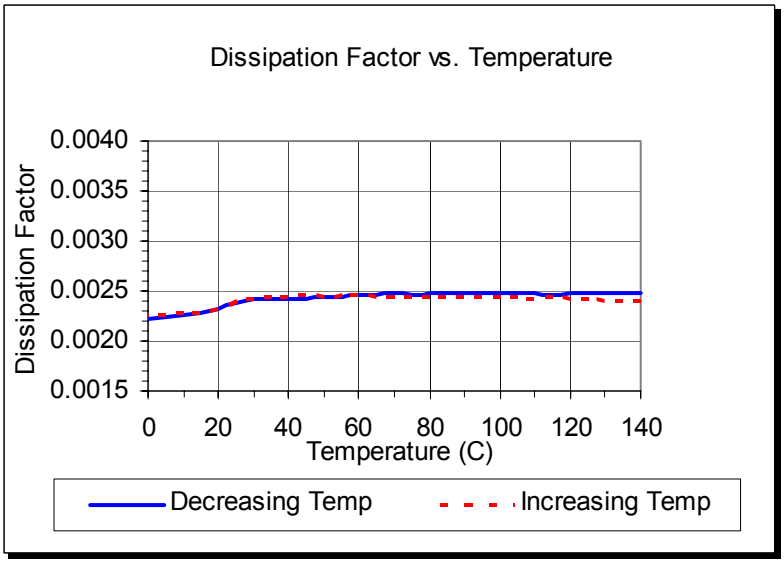


FIGURE 4

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

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 Arlon laminates may vary, depending on the design and application.

Multilayer Lamination Recommendations

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

Prepreg Material

- The Prepreg material consists of woven fiberglass fabric coated with a proprietary resin formulation. As received, the thickness of prepreg 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 that 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.

- Copper surfaces - Microtech 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

- 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 cycles.

- 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 at 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 - Because 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.

ARLON
MATERIALS FOR ELECTRONICS

CONTACT INFORMATION:

For samples, technical assistance, customer service or for more information, please contact Arlon Materials for Electronics Division at the following locations:

NORTH AMERICA:
Arlon, Inc.
Electronic Substrates
9433 Hyssop Drive
Rancho Cucamonga, CA 91730
Tel: (909) 987-9533
Fax: (909) 987-8541

Arlon, Inc.
Microwave Materials
1100 Governor Lea Road
Bear, DE 19701
Tel: (800) 635-9333
Outside U.S. & Canada: (302) 834-2100
Fax: (302) 834-2574

EUROPE:
Arlon, Inc.
44 Wilby Avenue
Little Lever
Bolton, Lancaster BL31QE
United Kingdom
Tel: (44) 120-457-6068
Fax: (44) 120-479-6463

SOUTHERN CHINA:
Arlon, Inc.
Room 805, Unit 3, Bldg 4
Liyuan, Xincun Holiday Road
Huaqiao Cheng, Shenzhen 518053
China
Tel/Fax: (86) 755-269-066-12

NORTHERN CHINA:
Arlon, Inc.
Room 11/401, No. 8
Hong Gu Road
Shanghai, China 200336
Tel/Fax: (86) 21-6209-0202

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