

# 91ML

## THERMALLY CONDUCTIVE MULTILAYERABLE EPOXY LAMINATE AND PREPREG



Arlon 91ML ceramic filled thermally conductive multifunctional epoxy laminate and prepreg products provide a low-cost, lead-free solder compatibility system with enhanced heat transfer characteristics for multilayer PWB's for applications requiring thermal management throughout the entire board volume.

### Features:

- Thermal Conductivity 1.0 W/m-K, 3-4x that of FR-4, reduces hot-spots and dependence on thermal vias and heat-sinks to dissipate heat
- Glass Transition Temperature 170°C provides excellent plated through hole reliability, lead-free solder application
- Decomposition temperature >350°C is ideally suited for lead-free solder processing and offers significant improvement over other thermally conductive laminate materials
- Coefficient of Thermal Expansion close to that of Copper and Aluminum for planar stability during process
- Best-in-class thermal performance with T260>60 minutes, T280>30 minutes and T300 > 10 minutes.
- Electrical Strength of >1000 Volts/mil for use in high power handling Applications
- Engineered for use with metal backing for producing Metal-Clad PCBs
- Certified to the flammability requirements of UL-94 V-0
- RoHS & WEEE Compliant
- Halogen-free per IPC4101 specifications

### Typical Applications:

- High Brightness LED's
- DC-DC Power Converters
- Automotive Electronics
- Electronic designs with limited thermal management alternatives

# Typical Properties:

**91ML**

Property	Units	Value	Test Method
<b>1. Electrical Properties</b>			
Dielectric Constant ( <i>will vary with Resin %</i> )			
@ 1 MHz	-	5.5	IPC TM-650 2.5.5.3
@ 1 GHz	-		IPC TM-650 2.5.5.9
Dissipation Factor			
@ 1 MHz	-	0.017	IPC TM-650 2.5.5.3
@ 1 GHz	-		IPC TM-650 2.5.5.9
Volume Resistivity			
C96/35/90	MΩ-cm	2.8 x 10 <sup>8</sup>	IPC TM-650 2.5.17.1
E24/125	MΩ-cm	1.2 x 10 <sup>7</sup>	IPC TM-650 2.5.17.1
Surface Resistivity			
C96/35/90	MΩ	4.4 x 10 <sup>7</sup>	IPC TM-650 2.5.17.1
E24/125	MΩ	1.7 x 10 <sup>7</sup>	IPC TM-650 2.5.17.1
Electrical Strength	Volts/mil (kV/mm)	>1000	IPC TM-650 2.5.6.2
Dielectric Breakdown	kV	43	IPC TM-650 2.5.6
Arc Resistance	sec	193	IPC TM-650 2.5.1
Dielectric Withstand Voltage (HiPot)	VDC	>5000	IPC TM-650 2.5.7.2
<b>2. Thermal Properties</b>			
Glass Transition Temperature (Tg)			
TMA	°C	160	IPC TM-650 2.4.24
DSC	°C	170	IPC TM-650 2.4.25
Decomposition Temperature (Td)			
Initial	°C	354	IPC TM-650 2.3.41
5%	°C	368	IPC TM-650 2.3.41
T260	min	>60	IPC TM-650 2.4.24.1
T288	min	>30	IPC TM-650 2.4.24.1
T300	min	>10	IPC TM-650 2.4.24.1
CTE (x,y)	ppm/°C	23	IPC TM-650 2.4.41
CTE (z)			
< Tg	ppm/°C	36	IPC TM-650 2.4.24
> Tg	ppm/°C	192	IPC TM-650 2.4.24
z-axis Expansion (50-260°C)	%	2.6	IPC TM-650 2.4.24
<b>3. Mechanical Properties</b>			
Peel Strength to Copper (1 oz/35 micron)			
After Thermal Stress	lb/in (N/mm)	5.0	IPC TM-650 2.4.8
At Elevated Temperatures	lb/in (N/mm)		IPC TM-650 2.4.8.2
After Process Solutions	lb/in (N/mm)	4.5	IPC TM-650 2.4.8
Young's Modulus	Mpsi (GPa)		IPC TM-650 2.4.18.3
Flexural Strength	kpsi (MPa)	31-49	IPC TM-650 2.4.4
Tensile Strength	kpsi (MPa)		IPC TM-650 2.4.18.3
Compressive Modulus	kpsi (MPa)		ASTM D-695
<b>4. Physical Properties</b>			
Water Absorption	%	0.13	IPC TM-650 2.6.2.1
Specific Gravity	g/cm <sup>3</sup>	2.05	ASTM D792 Method A
Thermal Conductivity—Z-Axis	W/mK	1.0	ASTM E1461
Thermal Conductivity—X/Y-Axis	W/mk	1.9	ASTM E1461
Flammability	class	Meets V-0	UL-94

Results listed above are typical properties, provided without warranty, expressed or implied, and without liability. Properties may vary, depending on design and application. Arlon reserves the right to change or update these values.

## Availability:

Arlon Part Number	Glass Style	Resin %	Nominal Press Thickness (mils)	Notes/Applications
91ML0488	104	~88%	3.0	Multilayer
91ML0690	106	~90%	4.0	Multilayer
91ML2380	2313	~80%	8.0	Multilayer

Laminate available in a wide variety of thicknesses with 1/2, 1 or 2 oz copper. Inquire about Aluminum, Copper or Brass plate availability.

## Recommended Process Conditions:

Process inner-layers through develop, etch, and strip using standard industry practices. Bake inner layers in a rack for 30 minutes at 225°F - 250°F (107°C - 121°C) immediately prior to lay-up. Vacuum desiccate the prepreg for 8 - 12 hours prior to lamination.

### Lamination Cycle:

1) Control the heat rise to 9°F - 12°F (5°C - 7°C) per minute between 180°F and 280°F (82°C and 121°C)

2) Starting point laminating pressure for 91ML for standard panel sizes are as follows:

Panel Size		Pressure	
in	cm	psi	kg/sq cm
12 x 18	30 x 40	250-300	17-21
18 x 24	40 x 61	300-350	21-24

3) Product temperature at start of cure = 360°F (182°C).

4) Cure time at temperature = 90 minutes

5) Cool down under pressure at  $\leq 10^\circ\text{F}/\text{min}$  ( $5^\circ\text{C}/\text{min}$ )

Drill at 350 SFM. Undercut bits are recommended for vias 0.018" and smaller

De-smear using alkaline permanganate or plasma with settings appropriate for multifunctional epoxy.

Conventional plating processes are compatible with 91ML

Standard profiling parameters may be used.

Bake for 2 hours at 250°F (121°C) prior to solder reflow

# 91ML

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