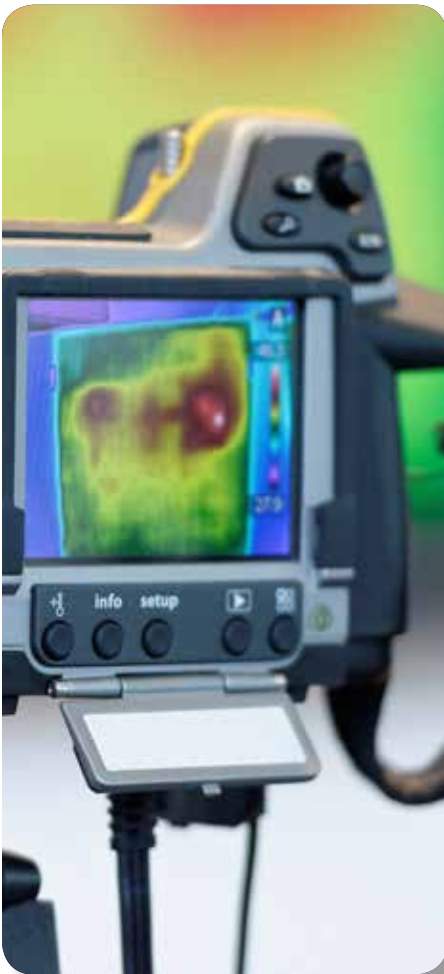


# 91ML

## Thermally Conductive Multilayerable Epoxy Laminate and Prepreg



Arlon 91ML ceramic filled thermally conductive multifunctional epoxy laminate and prepreg products provide a cost-effective, lead-free solder compatible, system with improved coefficient of thermal conductivity ( $T_c=1.0 \text{ W/m-K}$ ) for multilayer PWBS application that require thermal management throughout the board. 91ML has a UL-94 V0 halogen-free flame retardant system that is compliant with ROHS and WEEE and IPC-4101 requirements.



### Features:

- Thermal Conductivity ( $T_c$ )  $1.0 \text{ W/m-K}$ , 3-4x that of FR-4, reduces hot-spots and dependence on thermal vias and heat-sinks to dissipate heat
- Glass Transition Temperature  $160^\circ\text{C}$  provides excellent plated through hole reliability, lead-free solder application
- Decomposition temperature  $>350^\circ\text{C}$  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  $T_{260} > 60$  minutes,  $T_{280} > 30$  minutes and  $T_{300} > 10$  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 V0
- RoHS & WEEE Compliant
- Halogen-free per IPC-4101 specifications

### Typical Applications:

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

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## Typical Properties:

Property	Units	Value	Test Method
<b>1. Electrical Properties</b>			
Dielectric Constant			
@ 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)			
DSC	°C	160	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 (0.88)	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 (0.79)	IPC TM-650 2.4.8
Young's Modulus	Mpsi (GPa)	2.6 (18)	IPC TM-650 2.4.18.3
Flexural Strength	kpsi (MPa)	40 (275)	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

## 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 107°C - 121°C (225°F - 250°F) immediately prior to lay-up. Vacuum desiccate the prepreg for 8 - 12 hours prior to lamination.

### Lamination Cycle:

- 1) Control the heat rise to 5°C - 7°C (9°F - 12°F) per minute between 82°C and 121°C (180°F and 280°F)
- 2) Starting point laminating pressure for 91ML for standard panel sizes are as follows:

Panel Size		Pressure	
in	cm	psi	kg/cm <sup>2</sup>
12 x 18	30 x 40	250-300	17-21
18 x 24	40 x 61	300-350	21-24

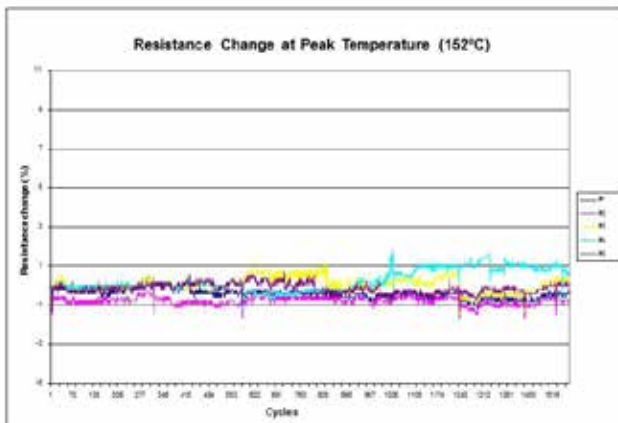
- 3) Product temperature at start of cure = 182°C (360°F).
- 4) Cure time at temperature = 90 minutes
- 5) Cool down under pressure at ≤ 5°C/min (10°F/min)

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 121°C (250°F) prior to solder reflow



Graph x? shows the results of Interconnect Stress Testing (IST) for 91ML. The test vehicle consisted of a 12 layer PWB using 5 oz copper and having an aspect ratio of 121. After pre-conditioning of 3X at 260°, the boards were thermally cycled from ambient to a peak temperature of 152°C and showed very little change in resistance for 1600 cycles. The coupons were manufactured by Pro-Tech Interconnect Solutions in Chaska, MN and the IST testing was completed by PWB Interconnect Solutions in Ottawa, Ontario, CA.

Optimal processing requirements may vary depending on specific equipment and operating conditions. These recommendations are offered only as a starting point.

# 91ML



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## Arlon Electronic Substrates... Challenge Us

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

### **NORTH AMERICA:**

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

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

### **NORTHERN EUROPE:**

Arlon LLC  
44 Wilby Avenue  
Little Lever  
Bolton, Lancashire BL31QE  
United Kingdom  
Tel: (44) 120-457-6068  
Fax: (44) 120-479-6463

### **SOUTHERN CHINA:**

Arlon LLC  
Room 601, Unit 1, Bldg 6  
Liyuan, Xincun Shahe  
Shenzhen, China 518053  
Tel: (86) 755-269-066-12  
Fax: (86) 755-26910475

### **NORTHERN CHINA:**

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

### **SOUTHERN EUROPE:**

Arlon LLC  
6 cours des Juilliottes  
94700 Maisons-Alfort France  
Phone : (33) 1 84 23 41 51  
Fax: (33) 9 55 62 43 26

**[www.arlon-med.com](http://www.arlon-med.com)**