



ARLON Materials for Electronics

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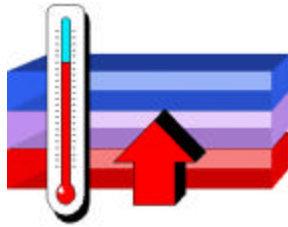
December 2003

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Arlon Introduces 99ML Thermally Conductive Laminate and Prepreg

What's New at Arlon? – A Look at the "Latest and Greatest"

Arlon Introduces 99ML Thermally Conductive Laminate and Prepreg



Building on initial successful results with 99N Thermally Conductive No-Flow prepreg, designed for use in bonding printed circuit boards to heat sinks, Arlon recently introduced to selected Beta customers samples of its new 99ML product, the flagship product in a full line of thermally conductive laminates and prepregs for applications where it is necessary to mitigate the issue of heat localizing underneath an active component on the board.

The management of heat on PWB's has become a major consideration in design and applications in many product areas in recent years with the seemingly unending trend for smaller and faster leading to higher and higher watt density on the board package. With power needs not only not decreasing, but in some cases increasing, how to manage the generated heat becomes a universal issue, with solution sets ranging from water cooled heat sinks mounted directly on high powered chip packages to water sprayed from an ink jet head directly on hotspots in devices.

99ML is based on a 175°C Tg multifunctional epoxy system loaded with thermally conductive ceramics giving a product with thermal conductivity of 1.1 W/m-K that will provide seamless compatibility with the 99N No-Flow prepreg system. The state of the art multifunctional epoxy technology in the resin system will withstand the higher temperatures expected with high power systems as well as resisting temperatures of lead-free solder systems that are expected to be phased in worldwide over the next several years in response to health and safety concerns over the use of lead-based.

Targeted initially at applications such as DC power converters, electric motor controls and automotive under-hood applications, 99ML is currently available both as copper clad laminate

(with copper weights up to 5 ounce for extra heat dissipating capability) and prepreg for homogeneous multilayer bonding. Sample materials are available for evaluation.

Arlon's 99ML is currently available in two prepreg formats, styles 106 (0.0053") and 1080 (0.0058") and in laminates of nominal 0.005", 0.006", 0.010" and 0.012" thicknesses. As mentioned, copper cladding up to 5 ounce is available as required for additional heat removal capacity. Basic product properties are summarized in the table below:

FEATURES	BENEFITS
<ul style="list-style-type: none"> • Thermal Conductivity 1.1 W/m-K 	<ul style="list-style-type: none"> • Reduced dependence on thermal vias to dissipate heat
<ul style="list-style-type: none"> • Glass Transition Temp. 175°C 	<ul style="list-style-type: none"> • Good PTH Reliability
<ul style="list-style-type: none"> • Electrical Strength >1200 V/mil 	<ul style="list-style-type: none"> • Use in high power applications
<ul style="list-style-type: none"> • Compatible with Arlon 99N No-Flow Product 	<ul style="list-style-type: none"> • Bond PWB's to Heatsinks with well-matched no flow system
<ul style="list-style-type: none"> • Flammability UL-94 V0 	<ul style="list-style-type: none"> • Meet Flammability Standards

A lot of discussion centers on heat flux and how to measure it. The coefficient of thermal transfer (W/m-K) is less important in many instances than the thermal resistance (usually expressed in °C/W) which takes into account the issue of interface resistance. Unfortunately there is not a good standard test for this since it has slightly different implications for every combination of materials, boards and heat sinks. Basically the interface between a hot object and the thermal interface material carrying that heat away is one of the most critical elements of a heat management solution. As 99ML is a full flow epoxy prepreg, it wets and bonds intimately to all the surfaces being bonded, thus minimizing concern about interface effects.

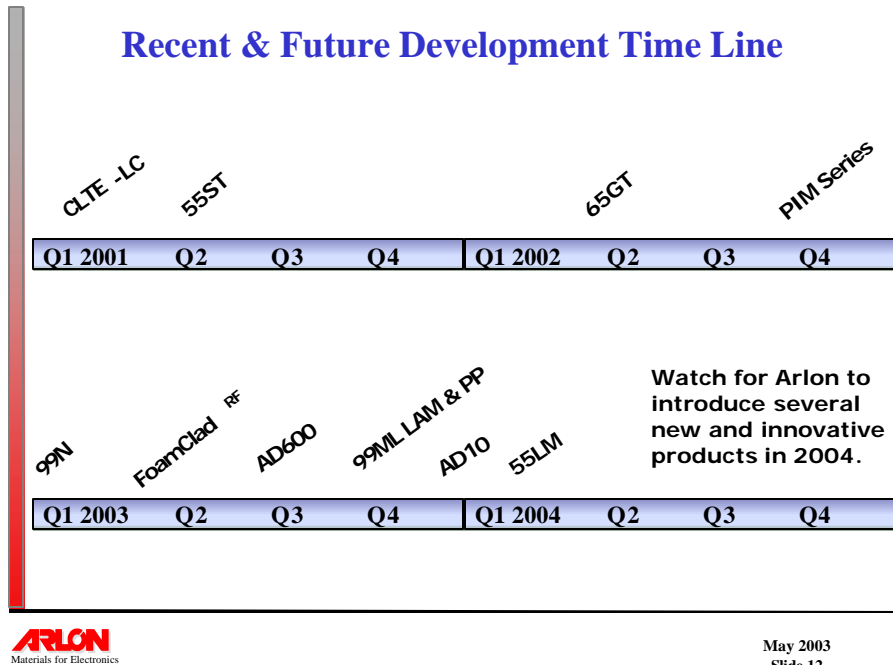
As an example, diamond has a thermal conductivity of 900 W/m-K – it is one of the most thermally conductive solid materials known to man. A thin slice of artificial diamond should remove heat very effectively from any surface, but all surfaces have micro irregularity, and a thin hard material makes very poor contact with both surfaces, so only a fraction of its potential capability to remove heat would be actualized. That's why most Thermal Interface Materials (TIM's) are soft and pliable such as filled silicone rubbers, or in paste form, or that melt and flow into the surfaces when heated (Phase Change materials).

No area of our complex world is entirely free from discussion about thermal issues and materials, as evidenced by the topic of one paper that was presented at the recent IMAPS Thermal Conference held in Palo Alto, CA, in which the specter of Cold War politics seems combined with the issues of thermal management. The paper, entitled "Thermal Simulations Applied to Embedded Cryptographic Coprocessor Devices" indicates the breadth of interest in this subject.

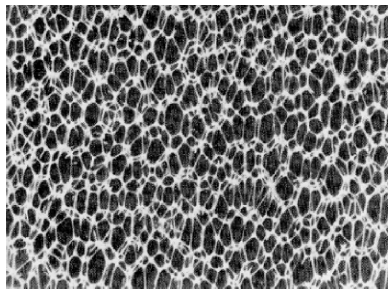
For additional information or samples of 99ML for evaluation in your application, please contact your local Arlon sales representative or contact Arlon directly at (909) 987-9533.

What's New at Arlon?

Long-time readers of this newsletter may recognize some of the new products we are featuring here, either because we talked about them in a previous newsletter or you saw them prophesied in our Technical Roadmap. We remain committed to investing in R&D and are proud of the results we have achieved over the past several years. We think it appropriate to end the year with the presentation – or re-presentation of some of the highlights of products that were introduced recently.



- **FoamClad^{RF} 100 Laminate**



FoamClad^{RF} **100** is a unique patent-pending copper-clad laminate product that is composed of a layer of microporous closed cell foam protected on both sides by an impermeable polymeric membrane that resists PWB process chemistries. With dielectric constant as low as 1.15 in the thickest product (about 0.100") this material is a low cost alternative to conventional materials, including metal, for production of cellular antennas. FoamClad^{RF} **100** is available in several thicknesses, single or double-sided.

Single-sided product is supplied with pressure sensitive adhesive and a polymeric release film on the back side to facilitate mounting to a ground plane or in an enclosure. In addition to low dielectric constant and loss values, FoamClad^{RF} 100 has been tested for PIM and shown values as low as -165 dBc (3rd Order) and -175 dBc (5th Order) at GSM frequencies.

AD-10 Thin High Dielectric Constant Product

Recently introduced to fill a need in the component marketplace for a thin, low loss high dielectric constant material for use in applications where capacitive properties are critical such as capacitive couplers, Arlon's AD-10 is finding a receptive audience in the component design community. Woven fiberglass reinforcement also offers better dimensional properties to the fabricator when compared with unsupported high Dk thin products. At Er 10.2 and only 0.0024" thick, AD-10 is offered standard with ½, 1 or 2 ounce copper foil in master sheet sizes from 36 x 48" up to 36" x 72".

AD-600 – Improved Er 6.15 Product

Recently introduced, AD-600 is an improved – and significantly cost-reduced – version of Arlon's venerable AR-600. With dielectric constant of 6.15 and loss tangent of 0.003, the new product also represents a 15-40% cost reduction, depending on laminate thickness, over the traditional AR-600 product. In addition it features excellent copper peel (12 lb/in) and substantially lower water absorption values (0.4% vs 0.8% for the traditional product) as well. It is expected that with the introduction of AD-600, customers will migrate designs to the lower cost, improved product.

CLTE-LC – Economically Priced Thermally Stable Er

Arlon's CLTE products with stable dielectric constant over a wide range of temperature and outstanding handling ability through PWB manufacture has long been one of the "flagships" of Arlon's microwave/RF laminate product line. Using the same ratios of resin, ceramic filler and glass as the CLTE products, CLTE-LC utilize heavier glass fabrics to enable building thicker laminates faster and at lower cost without sacrificing the stable electrical and mechanical properties that have been at the heart of the success of the product line. In thicknesses of 0.010" and higher, and depending on the thickness used, CLTE-LC offers savings of 15-20% over the traditional product. CLTE-LC is also completely compatible with the CLTE-P bonding sheet for multilayer lamination.

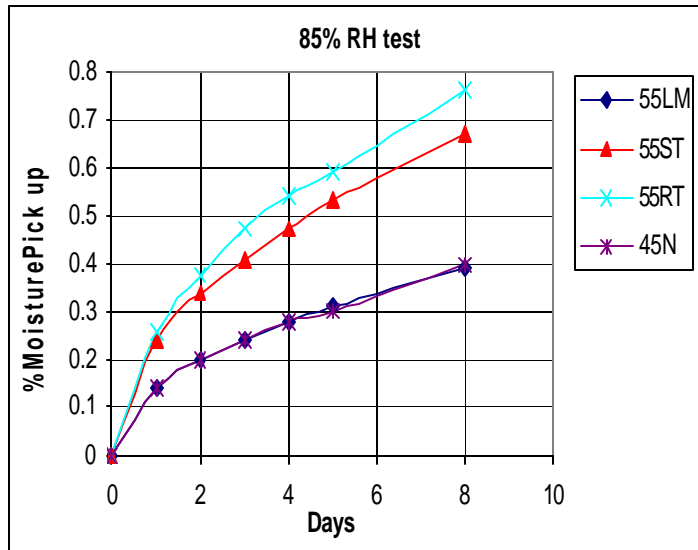
- **65GT "Green" Nonwoven Aramid**



The demand for "green" laminate and lead-free solder in consumer electronics is largely being driven by suppliers of consumer products in Japan and Europe. Although the EU has not formally banned TBBA (tetrabromobisphenol-A) from use in FR laminates, and IPC has recently declared the "green" laminate issue to be a marketing issue rather than one based on scientific evidence of environmental or health harm, major users of PWB's have made corporate decisions to be "environmentally friendly" and are driving to the use of such materials in handsets and other consumer electronics. 65GT was developed to achieve UL-94 V0 using a completely halogen and

antimony-free flame retardant system. Based on the Thermount® nonwoven aramid system, 65GT was initially aimed at the HDI handset market but is expected to see a broadening of demand as "green" products gain increasing market share.

- **55LM Multilayerable Low Moisture Regain Epoxy-Nonwoven Aramid**



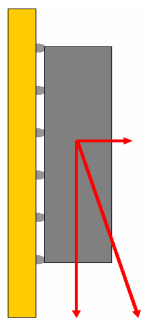
Still in Beta-testing but looking like a winner is another variant on the IPN technology that enabled Arlon to develop the 55ST product is 55LM (LM for "Low Moisture"), a new product with moisture regain essentially identical to that of multifunctional FR-4.

One of the considerations in the use of nonwoven aramid products has always been its tendency to absorb moisture rapidly, a consideration that has necessitated a series of often time-consuming bake steps in the process that are not necessary when handling traditional epoxy materials. Arlon's

55LM product (as illustrated in the graph, left) exhibits moisture pickup much less than other NWA products (such as 55RT and 55ST) and almost equivalent to 45N multifunctional epoxy-glass product, even at high humidity exposure (the pictured data was developed at 85% RH).

When this product has been thoroughly tested in a variety of applications, we believe that the savings in bake time and reduction in inconvenience will make it the material of choice for many applications where ambient humidity and temperature make use of conventional epoxy-NWA problematic.

55ST – High Peel Strength Nonwoven Aramid



The earliest releases of epoxy based nonwoven aramid products had marginal cohesive strength and resulting low apparent copper peel values (cohesive failures in the range of 3-5 lb/in depending on the resin content and type of copper foil). The result of this was that in hand-held devices such as cellular handsets, when a unit was dropped it was possible for the shear and perpendicular components of the force vector to cause a soldered component to come loose from the PWB. Since a 1 meter drop test is a routine part of most handset vendors' requirements, it was incumbent on Arlon to find a way to significantly improve this to permit NWA to be used in these applications.

The development of a resin system that created a tightly interpenetrating polymer network with the aramid fiber base material resulted in much improved internal cohesive strength and peel values of 9-10 lb/in with 1 ounce copper foil, easily exceeding the target of 8 lb/in that was suggested by the OEM design community. 55ST is rapidly replacing earlier generation epoxy nonwoven-aramid products as the improved peel and cohesive strength are proven to give measurably improved results in drop and impact testing.

99N and 99ML Thermally Conductive Products

At risk of seeming repetitious, although our lead article in this issue discusses 99ML at some length it touches only briefly on the first entry into our line of thermally conductive materials, that being 99N, a no-flow product designed primarily to bond heat sinks to PWB's. With a high lap shear strength (750 to 1000 psi typical) to aluminum and other materials used as heat sinks and a thermal conductivity of 1.2 W/m-K, 99N is finding application where the bonding interface is the "weak link" in the movement of heat from a PWB to a heat sink. Compared to a standard no flow product used in heat sink bonding (such as Arlon's 49N) the 99N product offers more than 4 times the thermal conductivity, and since it is a flowable material, the irregularities in the mating surfaces that often result in increased thermal impedance are completely filled by the resin during lamination.

PIM Grade Microwave Products

In new antenna designs, the requirement that Passive Intermodulation Distortion be kept below -155 dBc has become a part of virtually every specification. As new generations of cellular base stations are being called on to handle multiple frequencies through the same antenna, the issue of 3rd or 5th order intermodulation products potentially interfering with incoming low powered signals at adjacent frequencies becomes increasingly critical. Since its initial introduction of PIM-improved products, Arlon has continually broadened its line of PIM products to include not only the original premium product, DiClad 880 (dielectric constant 2.17/2.20), but also several of our commercial PTFE-based product grades -- AD250, AD300, AD320 and AD350 (dielectric constant respectively 2.5, 3.0, 3.2 and 3.5). In addition to its PTFE products, Arlon's new FoamClad^{R/F} 100 product also has a PIM value of better than -155 dBc.

Closing Notes: Farewell to the Old and In With the New

As we enter the Holiday Season we can look back on a year that saw continuing change in the PWB and laminate world. As an industry most are more optimistic about the future now as we see a slow but steady improvement in order input both at the board shop level and as laminators. The movement of production to Asia continues, however, many industry mavens see ongoing opportunity in the high end, IP sensitive, military and quick-turn areas for N. America and Europe, where the economies of long-run high volume and lower labor costs are not overriding factors.

However you personally celebrate the holiday season, I wish you all the joy of the Season and a Happy and Prosperous 2004!

Chet Guiles

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