DUPONT™ PYRALUX® TK

FLEXIBLE CIRCUIT MATERIALS

DESCRIPTION

DuPont™ Pyralux® TK flexible circuit material is a flexible copper clad laminate and bonding film system specifically formulated for high-speed digital and high-frequency flexible circuit applications. With a dielectric constant (Dk) of 2.3 to 2.5, and low loss (Df) of 0.0015 to 0.002 depending on the ratio of Teflon™ to DuPont™ Kapton® polyimide film.

The clad dielectric is a proprietary layered composite of Teflon™ and Kapton® films. The available copper foils are 12, 18 and 36 micron rolled annealed (RA) copper, and 12, 18 and 36 micron low profile electrodeposited (ED) copper foil.

The bonding film is also a layered dielectric, made with Teflon™ and Kapton® films. The bonding film contains a Teflon™ film that is processed at a lower lamination temperature than the clad.

APPLICATIONS

Pyralux® TK laminate and bondply films are designed for high speed flex applications, including microstrip and stripline controlled impedance constructions. Key property advantages are:

- Low dielectric constant
- Low loss tangent
- Low moisture absorption
- Tight thickness tolerance
- Better flexibility
- Thin—50, 75, and 100 microns

CONSTRUCTIONS

TK Dielectric is a composite made from a Kapton® core and thicknesses of Teflon™ above and below. There are three thicknesses of cladply dielectric available.

Pyralux® TK flexible circuit material is available in a variety of thicknesses. TK clads with RA copper end in R; clads with ED copper end in E. Asymmetric constructions such as TK1810036R are available on request.

Table 1 - Cladply Dielectric Options

Clad Dielectric Thickness	Teflon™ micron	Kapton® micron	Teflon™ micron
50 micron	12.5	25	12.5
75 micron	19	38	19
100 micron	25	50	25

Table 2 - DuPont™ Pyralux® TK Clads - RA Copper

Pyralux® TK Code	Copper micron	Dielectric micron	Copper micron
TK185018R	18	50	18
TK187518R	18	75	18
TK1810018R	18	100	18
TK365036R	36	50	36
TK367536R	36	75	36
TK3610036R	36	100	36
TK125012R	12	50	12
TK127512R	12	75	12
TK1210012	12	100	12

ED versions of above constuctions are available.

Add “R” to the end of the code to specify rolled-annealed copper foil (e.g., TK185018R). Add “E” to the end of the code to specify electro-deposited copper foil (e.g., TK185018E).

Table 3 - DuPont™ Pyralux® TK Bonding Films

Pyralux® TK Code	Teflon™ micron	Kapton® micron	Teflon™ micron
TK252525	25	25	25
TK255025	25	50	25
TK445044	44	50	44

PACKAGING

Pyralux® TK clads are supplied in a sheet form, with standard dimensions of 24” x 36”, 24” x 18”, and 12” x 18” (610 x 914mm, 610 x 457mm, and 305 x 457mm). Other dimensions are available upon request.

Pyralux® TK bonding films are supplied on 610 mm (24 in) wide by 76 m (250 ft) long rolls, on nominal 76 mm (3 in) cores. Other widths and lengths are also available, as well as sheets.

SPECIFICATIONS

UL V-0

IPC-4204/13 (clad)

IPC-4203/5 (bonding film)

RoHS Compliant

Pb-Free alloy compatible

DuPont™ Pyralux® TK Copper Clad Laminate

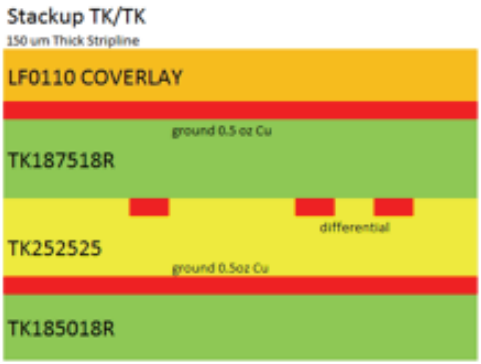
Property	Pyralux® TK185018R	Pyralux® TK187518R	Pyralux® TK1810018R
Dielectric Constant 10 GHz, Normal*	2.5	2.5	2.5
Dielectric Constant 10 GHz, In-plane**	2.8	2.8	2.8
Loss Tangent 10 GHz	0.002	0.002	0.002
Peel Strength AR, N/m (pli), 18 µm Cu	1200 (7)	1200 (7)	1200 (7)
Peel Strength AS, N/m (pli), 18 µm Cu	1200 (7)	1200 (7)	1200 (7)
Peel Strength After HAST, N/m (pli), 18 µm Cu	900 (5)	900 (5)	900 (5)
Moisture Absorption, %	0.6	0.6	0.6
Solder Float, 3 min at 288°C	Pass	Pass	Pass
Dimensional Stability % Method B, After Bake, MD/TD Method C, After Bake, MD/TD	 -0.05/-0.07 -0.07/-0.13	 -0.04/-0.06 -0.06/-0.11	 -0.03/-0.05 -0.05/-0.10
MIT Flex Test, with LF coverlay	730	404	N/A
CTE, ppm/C (50 to 250°C)	27	27	27
Modulus, MPa (kpsi)	3250 (470)	3100 (450)	3170 (460)
Tensile Strength, MPa (kpsi)	185 (27)	185 (27)	185 (27)
Elongation, %	60	70	70
Dielectric Strength, volts/um (volts/mil)	200 (5000)	190 (4800)	170 (4300)
Flame Rating, UL	V-0	V-0	V-0
RTI, UL	200°C	200°C	200°C
Decomposition Temperature 2%/5%	531oC/548°C	531oC/548°C	531oC/548°C

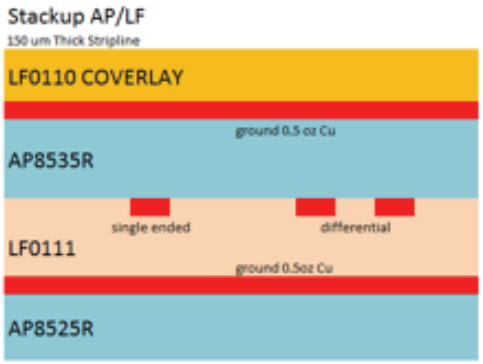
*IPC-TM-650-2.5.5.5 value to be used in design calculations. **In-plane values are bulk properties measured by ASTM-D-2520
HAST Conditions are: 2 atm, 120°C, 90% humidity, 96 hours. MIT Flex Test: 18 µm copper lines, 0.38 mm radius

DuPont™ Pyralux® TK Bondply

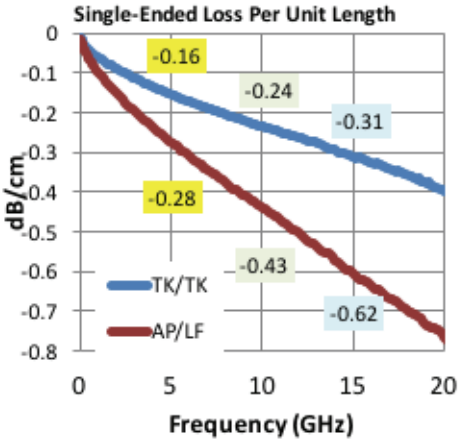
Property	Pyralux® TK252525 Bondply	Pyralux® TK255025 Bondply	Pyralux® TK445044 Bondply
Dielectric Constant 10 GHz, Normal*	2.3	2.5	2.4
Dielectric Constant 10 GHz, In-plane**	2.6	2.8	2.7
Loss Tangent 10 GHz	0.0015	0.002	0.0015
Peel Strength to Dielectric of TK Laminate, N/m (pli)	1000 (6)	1000 (6)	1000 (6)
Peel Strength AR to Copper Foil, N/m (pli), 36 µm Cu	875 (5)	875 (5)	875 (5)
Peel Strength AR, to Shiny Cu, N/m (pli), 18 µm Cu	500 (3)	500 (3)	500 (3)
Moisture Absorption, %	0.3	0.6	0.4
Solder Float, 10 sec at 288°C	Pass	Pass	Pass
Dielectric Strength, volts/um (volts/mil)	190 (4800)	170 (4300)	160 (4000)
UL Flame Recognition	V-0	V-0	V-0
Decomposition Temperature 2%/5%	494°C/514°C	494°C/514°C	494°C/514°C

*IPC-TM-650-2.5.5.5 value to be used in design calculations. **In-plane values are bulk properties measured by ASTM-D-2520

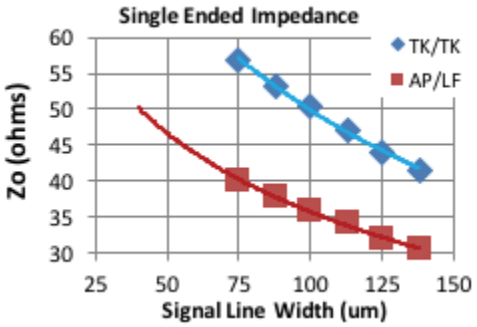


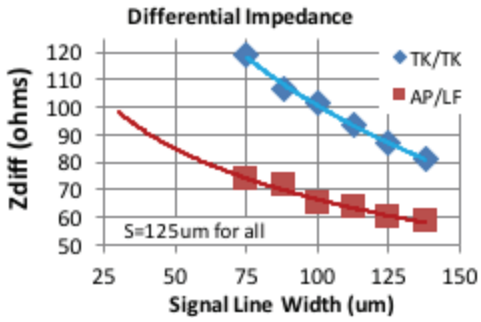


The above stackups were made to compare the performance of DuPont™ Pyralux® TK clad and bondply to the AP clad and LF bondply. The data in the next two graphs show data based on these two stripline designs.

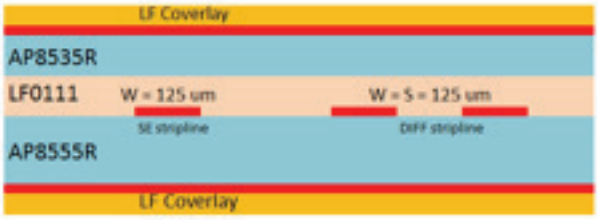


Graph above shows the loss in dB/cm up to 20 GHz. The TK constructions clearly shows much lower loss (dB is a log scale).





Graphs above show the impedance at different line widths for the two constructions. This shows the real advantage of lower Dk for making controlled impedance circuits. To achieve standard impedance targets at achievable line widths the AP/LF constructions would need to have a thicker dielectric between the two ground planes.



Simply replacing AP with TK in a standard flex can deliver flexibility benefits. Both stackups shown are 50 Ohms Single Ended and 100 Ohms Differential, but the TK stackup is significantly thinner and has much lower modulus than the standard flex stackup. LF bondply can be used for short lengths or longer lengths at frequencies less than 2 GHz.

PROCESSING SUGGESTIONS

Dimensional Stability

DuPont™ Pyralux® TK clads will shrink more than most other Pyralux® clads after etching, baking, and lamination. Use caution when designing with unbalanced clads to avoid curl after lamination. TK clads will shrink morein the TD direction than in the MD direction. TD is always listed first in clad dimensions. To reduce shrinkage keep as much copper as possible on the clads during imaging.

Full copper borders with sunburst channels for air escape will reduced the level of shrinkage after etching better than the dot pattern often used. When laminating TK bondply to TK clads, bleeder channels must be present to prevent entrapped air during lamination.

Clad Preparation for Bondply Lamination

Adhesion of treated copper foil to TK bondply varies with copper foil type and chemistry. Test adhesion before deciding on copper foil. Adhesion of TK bondply to shiny copper requires a good microetch of 25 – 50 microinches or more to achieve good adhesion. Alternative oxides yield higher adhesion. We successfully tested:

- Cobra Bond (OMG Group)
- Circubond (Dow, was Shipley)
- Bondfilm (Atotech)

Adhesion of TK bondply to TK clad dielectric is very good but TK bondply does NOT adhere well to Pyralux® AP dielectric. Do not touch or modify the Teflon™ surface of the TK clads after etching (i.e. no pumice scrubbing or plasma etching). This will remove the activated surface, which will reduce adhesion to TK bondply and standard coverlays.

Bondply Lamination

1. Bake sheets of bondply at 121C for 2 hours prior to layup to remove all moisture from Kapton® layer prior to laminating.
2. Start with cold press.
3. Pull vacuum for at least 30 minutes before applying pressure or heat.
4. Start pressure and heat. Aim peak temperature to 280 – 290°C (535 – 554°F). (Do not exceed 300°C (572°F)).
5. Aim pressure to a maximum of 250 psi (1.7 MPa). Lower pressures generally work better than higher pressures.
6. Ramp rate is not usually critical
7. Hold at peak temperature for 60 minutes to insure best adhesion.
8. Cool down under pressure. Cool down rate is not critical after temperature falls below 260°C (500°F). Cooling down too quickly above this temperature can lead to registration problems. TK Bondply adhesion to dielectric and copper surfaces is mainly determined by peak lamination temperature and time at peak temperature. Pressure has very little effect. This is even also true for conformation and flow of the TK bondply adhesive around circuitry.

   The long vacuum draw down time before heat and pressure is critical to preventing entrapped air voids. Increasing the thickness of the press pads is preferred over increasing pressure to improve encapsulation of traces. Lower pressure can improve registration in many cases.

The long vacuum draw down time before heat and pressure is critical to preventing entrapped air voids, which are a common defect observed during the development of the TK bondply lamination process. Increasing the thickness of the press pads is sometimes required to eliminate air voids that are observed in the thin circuit area.

Registration can be an issue with thicker TK multilayer flex circuits. Lower pressure can improve registration in many cases.

Press Pad Recommendations

Use press pads that can survive 280 to 290°C bondply lamination.

The following press pad systems have been tested to be compatible with TK bondply lamination:

- Themopad (Pacothane Industries)
- HeatShield (MRS Polymers)
- Themofilm (Pacothane Industries)
- Aluminum and Copper Foil

Due to the high temperature and long duration of the lamination, it is generally recommended not to re-use press pads.

Drilling and Through Hole Activation Recommendations

The procedures used today to drill and activate high speed PTFE boards should be adequate for DuPont™ Pyralux® TK flexible circuit materials. The Teflon™ in Pyralux® TK is chemically similar to the PTFE fluoropolymer used in rigid high speed laminate.

Open flute, thin web design drill bits work the best for TK drilling, these are usually marketed as “flex” tools by most tool manufacturers. Use new drill bits and limit hit count to 500. It is critical that the drill bits not get so hot that they start to melt the

Teflon™ layers. TK drill results are usually better with chip loads lower than for typical flex circuits. In many cases, Teflon™ smear may occur during drill bit retract. Therefore, hard backing materials that can clean the drill bits before retract work well (such as phenolic).

For circuit constructions with Teflon™ and other dielectrics, always run the desmear process for non-Teflon™ dielectric first. Then, run the activation process for the Teflon™. Therefore, Pyralux® TK could be desmeared initially in the same process used for Pyralux® AP and then followed by a Teflon™ preparation. None of the methods below will remove Teflon™ smear; they will only activate the surface for plating

Options for Teflon™ Activation

Sodium Etch: This is a Sodium Napthalene solution available from Poly-Etch or Fluoro-Etch. It works well and has been used for many years. Most PCB manufacturers who routinely run high speed PTFE boards will already have sodium etch available.

Plasma Etching: The Teflon™ can be prepared for plating with plasma etching. Run one of these gases as the last cycle. They are listed in order of most effective.

- Nitrogen/hydrogen mixtures (from 70/30 to 30/70) – Most effective
- Helium – If Nitrogen/Hydrogen is not available

The general goal is to remove the fluorine from the surface of the Teflon™ to improve wetting. That is why the standard gases for other dielectrics (CF4/02) should never be the last plasma gases used in a multistage process.

The activation of the Teflon™ surface is usually effective for 24 to 48 hours. Run electroless copper or direct plate within 1 to 2 days after hole wall activation.

Laser Drilling

DuPont™ Pyralux® TK works well with Carbon Dioxide lasers. We do not recommend laser drilling vias with standard UV lasers since the Teflon™ is transparent to the UV energy. Routing with UV lasers is possible if edge quality is not critical.

Coverlays

Pyralux® LF and FR coverlays are compatible with Pyralux® TK laminate. Using TK bondply as a coverlay is not recommended since the flow of the Teflon™ is very difficult to precisely control for pad openings.

Rigid-Flex

We recommend that the outer surface of the flex be TK clad and not TK bondply. The TK Bondply surface does not adhere as well to prepregs.

When laminating flex sublayers with TK clads and bondplies for rigid flex application, leave solid copper on the outerlayers during lamination step. Then image the outerlayers after lamination. This will make registration more manageable and improve adhesion of the prepregs to the surface of the TK clads. TK etched circuits should NOT be plasma etched before low flow prepreg lamination.

GENERAL INFORMATION

Handling

Pyralux® TK laminate and bondply are more sensitive to static build up than traditional flexible circuit materials because of the low moisture levels. After etching, handle sample carefully to prevent collection of particulate.

Safe Handling

Anyone handling DuPont™ Pyralux® TK flexible circuit materials should wash their hands with soap before eating, smoking, or using restroom facilities. Although DuPont is not aware of anyone developing contact dermatitis when using DuPont™ Pyralux® TK products, some individuals may be more sensitive than others.

Gloves, finger cots, and finger pads should be changed daily. DuPont™ Pyralux® TK flexible circuit materials are fully cured when delivered. However, lamination areas should be well ventilated with a fresh air supply to avoid build-up from trace quantities of residual solvent (typical of polyimides) that may volatilize during press lamination. When drilling or routing parts made with DuPont™ Pyralux® TK, provide adequate vacuum around the drill to minimize worker exposure to generated dust.

As with all thin, copper-clad laminates, sharp edges present a potential hazard during handling. All personnel involved in handling Pyralux® TK clads should use suitable gloves to minimize potential cuts.

DUPONT™ PYRALUX® TK

Quality and Traceability

DuPont™ Pyralux® TK flexible circuit materials are manufactured under a quality system registered to ISO9002 by Underwriters Laboratories. The clads are certified to IPC-4204/13. The TK bondplies are certified to IPC4203/5. Complete material and manufacturing records, which include archive samples of finished product, are maintained by DuPont. Each manufactured lot is identified for reference and traceability. The packaging label serves as the primary tracking mechanism in the event of customer inquiry and includes the product name, batch number, size, and quantity.

Storage Conditions and Shelf Life

Pyralux® TK flexible circuit materials will retain their original properties for a minimum of two years for the TK clad, and one year for the TK bondply, when stored in the original packaging at temperatures of 4-29°C and below 70% humidity. They do not require refrigeration.

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