



# 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 bendability
- Standard flex properties
- Wide processing latitude
- Thin—50, 75, and 100 microns

### CONSTRUCTIONS

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 - 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

ED versions of above constructions are available.

Table 2 - DuPont™ Pyralux® TK Clad Dielectrics

Pyralux® TK Total Thickness	Teflon® micron	Kapton® micron	Teflon® micron	% Teflon
TK 50 micron	12.5	25	12.5	50%
TK 75 micron	19	38	19	50%
TK 100 micron	25	50	25	50%

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

RoHS Compliant

IPC-4204/13 (clad)

Pb-Free alloy compatible

IPC-4203/5 (bonding film)

## 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	-0.01/-0.05 -0.04/-0.10	-0.05/-0.09 -0.08/-0.15	-0.03/-0.06 -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	200oC	200oC	200oC
Decomposition Temperature 2%/5%	531oC/548oC	531oC/548oC	531oC/548oC

\*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

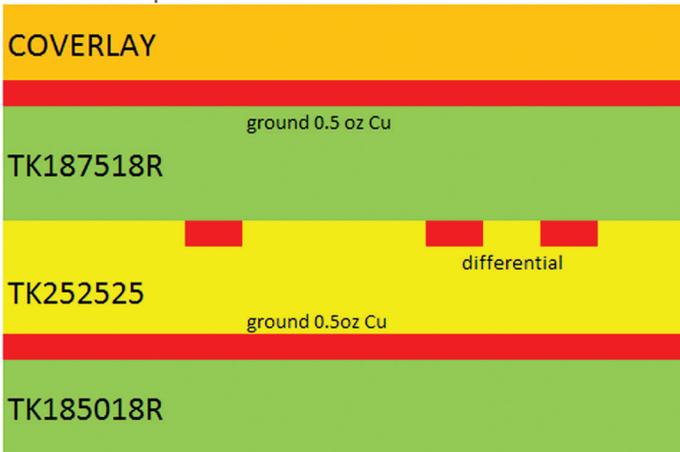
## DuPont™ Pyralux® TK Bondply

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

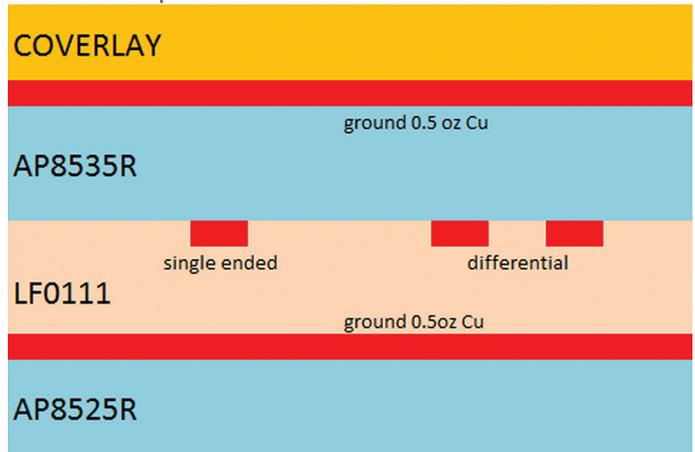
### Stackup TK/TK

150 um Thick Stripline

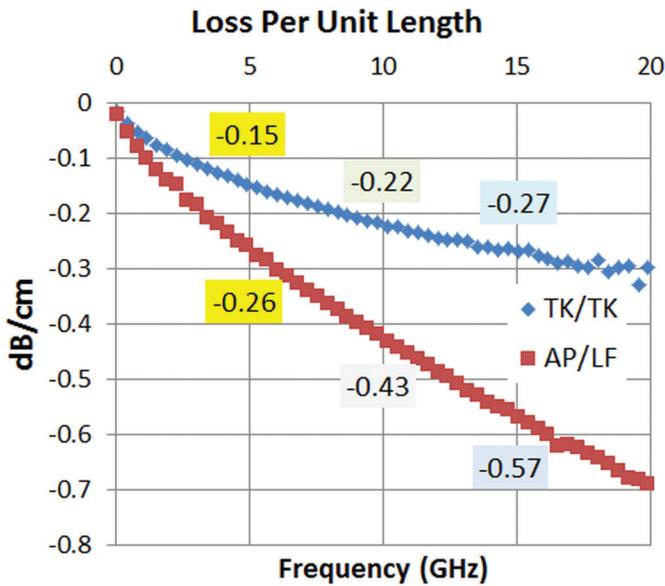


### Stackup AP/LF

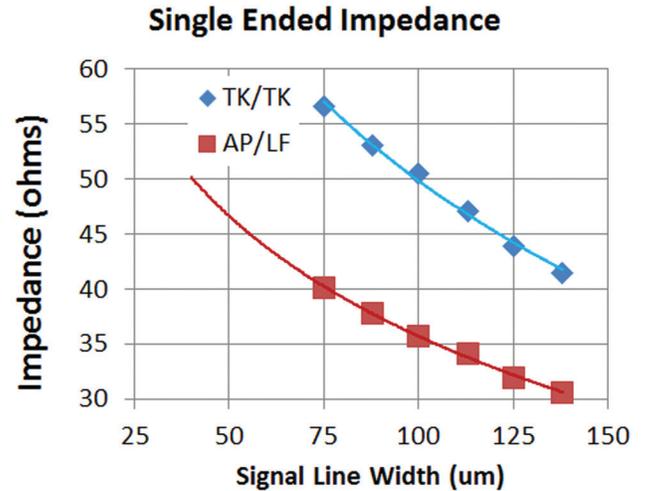
150 um Thick Stripline



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



Graph above shows 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.

## PROCESSING SUGGESTIONS

### Dimensional Stability

DuPont™ Pyralux® TK clads will shrink more than most other Pyralux® clads after etching and baking. TK clads will shrink more in 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. All TK clads should have similar shrinkage, so it should be easy to mix any of the 3 clads in the same multilayer board.

Full copper borders with sunburst channels for air escape will reduce 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. (We have found that Nikko RA coppers work well.)

Adhesion of TK bondply to shiny copper requires a good microetch of 40 microinches or more to achieve good adhesion. Alternative oxides give even 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. However, make sure to not damage 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. Start with cold press.
2. Pull vacuum for at least 30 minutes before applying pressure or heat.
3. Start pressure and heat. Aim peak temperature to 280–290°C (535–554°F). (Do not exceed 300°C (572°F)).
4. Aim pressure to a maximum of 250 psi (1.7 MPa). Lower pressures may work as well.
5. Ramp rate is not usually critical but slower ramps speeds can sometimes reduce entrapped air.
6. Hold at peak temperature for 60 minutes to insure best adhesion.

7. Cool down under pressure. Cool down rate is not critical. 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 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, 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 for bondply lamination. Possible options:

- Sheets of skived PTFE film along with sheets of copper and/or aluminum foil.
- We are still testing new press pads; contact DuPont for latest recommendations.

### 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 present high speed laminate.

To determine drilling conditions assume that TK is a soft flex material. 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 fresh 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 below the typical flex circuit chip loads. 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, one should 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 Naphthalene 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 as well. There are several different gases for preparing Teflon® layer. 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)
- Pure nitrogen
- Helium
- Oxygen

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 (CF<sub>4</sub>/O<sub>2</sub>) 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. Vias can be drilled with UV lasers but the hole wall quality is poor, because the Kapton® layer absorbs much more energy than the Teflon® layers. Routing with UV lasers is possible if edge quality is not critical.

Combined laser systems have been successfully used with TK: UV laser to create hole in copper and then CO<sub>2</sub> laser to drill the dielectric using the copper hole as the mask

Use standard through hole activation after laser drilling.

## Coverlays

Pyralux® LF and FR coverlays are compatible with Pyralux® TK laminate. The adhesion between the coverlay adhesive and the TK dielectric is very good. A few epoxy based coverlays have also demonstrated good adhesion based on internal testing.

## Rigid-Flex

Seven different prepregs used in rigid flex applications have shown very good adhesion to the dielectric surface of the TK clad even after solder floats. Both epoxy and polyimide prepregs were tested. For rigid flex builds, 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 much easier and should improve adhesion of the prepregs to the surface of the TK clads. TK circuits should not be plasma etched before low flow prepreg lamination.

As with most rigid flex application the drilling process will need to be optimized for drilling through the rigid and flex sections.

## 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.

**FOR MORE INFORMATION ON DUPONT™ PYRALUX® FLEXIBLE CIRCUIT MATERIALS, PLEASE CONTACT YOUR LOCAL REPRESENTATIVE, OR VISIT OUR WEBSITE:**

#### Americas

DuPont Electronic Technologies  
14 T. W. Alexander Drive  
Research Triangle Park, NC 27709  
Tel: 800-243-2143

#### Europe, Middle East & Africa

DuPont de Nemours  
(Luxembourg) s.à r.l.  
Rue Général Patton, Contern  
L-2984 Luxembourg  
Tel: +352 3666 5935

#### Japan

DuPont KK  
Sanno Park Tower  
11-1, Nagata-cho 2-chome  
Chiyoda-ku, Tokyo 100-6111  
Tel: 81-3-5521-8660

#### Taiwan

DuPont Taiwan Hsinchu Branch.  
#2, Li-Hsin 4th Rd., Hsinchu  
Science Park,  
Hsinchu 30078, Taiwan  
Tel: 886-3-5793654

#### India

E.I.DuPont India Limited  
1001-1012 “Meadows”, 10th  
Floor  
Sahar Plaza Complex  
Andheri-Kurla Road, Andheri  
(East)  
Mumbai 400 059, India  
Tel: 91-22-6751-5000  
DID: 91-22-6751-5038  
Fax : 91-22-67101937

#### China

DuPont China Holding Co., Ltd.  
Shanghai Branch  
Bldg. 11, 399 Keyuan Road  
Zhangjiang Hi-Tech Park  
Pudong New District  
Shanghai 201203, China  
Tel: 86-21-38622720

#### Korea

DuPont Korea Inc.  
4/5 Floor, Asia Tower  
#726, Yeoksam-dong, Kangnam-  
ku, Seoul  
135-082 Korea  
Tel: 82-2-2222-5224

#### Singapore

DuPont Singapore Pte, Ltd.  
1 HarbourFront Place #11-01  
HarbourFront Tower One  
Singapore 098633  
Tel: 65-6586-3091

[pyralux.dupont.com](http://pyralux.dupont.com)

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