



DUPONT™ PYRALUX® FR COPPER-CLAD LAMINATES

FLEXIBLE COMPOSITES

PRODUCT DESCRIPTION

DuPont™ Pyralux® FR copper-clad laminate is a composite of DuPont™ Kapton® polyimide film with copper foil on one or both sides, bonded together with a proprietary, flame-retardant, C-staged acrylic adhesive. Pyralux® FR flexible composites are recommended for use in single-sided, double-sided, multilayer, and rigid-flex circuits that require flame retardancy. All copper-clad laminates are available with rolled-annealed copper or electro-deposited copper. In addition, both types are available with double-treated copper (nodules of electro-deposited copper on both sides of the copper foil). Double-treated copper, if used, eliminates surface preparation steps prior to resist or coverlay lamination.

CONSTRUCTION

Copper-clad laminates are available in a variety of film thicknesses and copper weights. **Tables 1** and **2** list typical constructions.

The product code must be used when ordering sheet adhesive from DuPont

PACKAGING

Pyralux® FR copper-clad laminates are supplied in 24 in (610 mm) by 36 in (914 mm) sheets. There is a minimum of four sheets and a maximum of 25 sheets per pack.

TYPICAL DATA

Each manufactured lot, except the laminate constructions noted in **Tables 1** and **2**, is certified to IPC specifications and tested according to IPC Test Method TM-650. See **Table 3**.

A Certificate of Conformance is available with every batch. Complete material and manufacturing records for each lot, with samples of finished product, are retained for reference purposes. The roll labels contain the lot number, DuPont order number, customer order number, IPC specification, customer specification, and customer part number; save these labels for reference in case of inquiries.

Table 1. Copper-Clad Product Codes

Product Code*	Copper	Adhesive	Kapton®	IPC
	oz/ft ² (g/m ²)	mil (µm)	mil (µm)	Certification**
FR9110R	1 (305)	1 (25)	1 (25)	Yes
FR9120R	1 (305)	1 (25)	2 (51)	Yes
FR9130R	1 (305)	1 (25)	3 (76)	Yes
FR9150R	1 (305)	1 (25)	5 (127)	Yes
FR9210R	2 (610)	1 (25)	1 (25)	Yes
FR9220R	2 (610)	1 (25)	2 (51)	Yes
FR7012R	1/2 (153)	1/2 (13)	1/2 (13)	No
FR7002R	1 (305)	1/2 (13)	1/2 (13)	No
FR7062R	1/2 (153)	1/2 (13)	1 (25)	No
FR7011R	1 (305)	1/2 (13)	1 (25)	Yes
FR7008R	2 (610)	1/2 (13)	1 (25)	Yes
FR7092R	1 (305)	1/2 (13)	2 (51)	Yes
FR7004R	1/2 (153)	1 (25)	1/2 (13)	No
FR7037R	1 (305)	1 (25)	1/2 (13)	No
FR7038R	2 (610)	1 (25)	1/2 (13)	No
FR8510R	1/2 (153)	1 (25)	1 (25)	Yes
FR7031R	3/4 (229)	1 (25)	1 (25)	Yes
FR8520R	1/2 (153)	1 (25)	2 (51)	Yes
FR7019R	3/4 (229)	1 (25)	2 (51)	Yes
FR7097R	1 (305)	2 (51)	1 (25)	Yes

*Add "R" to the end of the code to specify rolled-annealed copper (e.g. FR9210R). Add "E" to the end of the code to specify electro-deposited copper (e.g. FR9210E). If rolled-annealed, double-treated copper is specified, add the letter "D" to the end of the product code (e.g. FR9210D).

**Certified to IPC-4204/1: "Flexible Metal-Clad Dielectrics for use in Fabrication of Flexible Printed Wiring."

DUPONT™ PYRALUX® FR COPPER-CLAD LAMINATES

Table 2. Double-Sided Copper-Clad Product Codes

Product Code*	Copper oz/ft ² (g/m ²)	Adhesive mil (μm)	Kapton® mil (μm)	IPC Certification**
FR9111R	1 (305)	1 (25)	1 (25)	Yes
FR9121R	1 (305)	1 (25)	2 (51)	Yes
FR9131R	1 (305)	1 (25)	3 (76)	Yes
FR9151R	1 (305)	1 (25)	5 (127)	Yes
FR9212R	2 (610)	1 (25)	1 (25)	Yes
FR9222R	2 (610)	1 (25)	2 (51)	Yes
FR7022R	1/2 (153)	1/2 (13)	1/2 (13)	No
FR7014R	1/2 (153)	1/2 (13)	1 (25)	No
FR7010R	1 (305)	1/2 (13)	1 (25)	Yes
FR7041R	2 (610)	1/2 (13)	1 (25)	Yes
FR7091R	1/2 (153)	1/2 (13)	2 (51)	Yes
FR7093R	1 (305)	1/2 (13)	2 (51)	Yes
FR7058R	2 (610)	1/2 (13)	2 (51)	Yes
FR7003R	2 (610)	1/2 (13)	3 (76)	No
FR7017R	1/2 (153)	1 (25)	1/2 (13)	No
FR7039R	1 (305)	1 (25)	1/2 (13)	No
FR7040R	2 (610)	1 (25)	1/2 (13)	No
FR8515R	1/2 (153)	1 (25)	1 (25)	Yes
FR8525R	1/2 (153)	1 (25)	2 (51)	Yes
FR7090R	2 (610)	2 (51)	2 (51)	Yes
FR7071R	1 (305)	1/2 (13)	1/2 (13)	Yes

*Add “R” to the end of the code to specify rolled-annealed copper (e.g. FR9210R). Add “E” to the end of the code to specify electro-deposited copper (e.g. FR9210E). If rolled-annealed, double-treated copper is specified, add the letter “D” to the end of the product code (e.g. FR9210D).

**Certified to IPC-4204/1: “Flexible Metal-Clad Dielectrics for use in Fabrication of Flexible Printed Wiring.”

PROCESSING

Laminating conditions for DuPont™ Pyralux® flexible composites are typically in the following ranges:

Part Temperature: 182–199°C (360–390°F)
 Pressure: 14–28 kg/cm² (200–400 psi)
 Time: 1–2 hours, at temperature

Pyralux® FR can be processed like Pyralux® LF. Refer to publication “Pyralux® Flexible Composites Technical Manual” for further processing details.

STORAGE CONDITIONS AND WARRANTY

Pyralux® FR flexible laminates should be stored in the original packaging at temperatures of 4–29°C (40–85°F) and below 70% humidity. The product should not be frozen and should be kept dry, clean and well-protected. Subject to compliance with the foregoing handling and storage recommendations, DuPont’s warranties, as provided in the DuPont Standard Conditions of Sale, shall remain in effect for a period of two years following the date of shipment.

Table 3. Pyralux® Copper-Clad Properties

Property	Typical Coverlay Value	Test Method
Flammability	VTM-0	UL94
Meets UL746E Direct Support Requirements	Yes	UL746E
UL Max Operating Temperature	105 °C (221 °F)	UL 746F
Peel Strength	–	IPC-TM-650, No. 2.4.9
After lamination	2.1 N/mm (12 lb/in)	Method B
After soldering	1.9 N/mm (11 lb/in)	Method D
Solder Float Resistance 10 sec at 288°C (550°F)	Pass	IPC-TM-650, No. 2.4.13 Method B
Thickness Tolerance	±10%	IPC-TM-650, No. 4.6.2
Dimensional Stability	-0.10%	IPC-TM-650, No. 2.2.4 Method B
	-0.10%	IPC-TM-650, No. 2.2.4 Method C
Dielectric Constance (at 1 MHz)	3.5	IPC-TM-650, No. 2.5.5.3
Dissipation Factor (at 1 MHz)	0.02	IPC-TM-650, No. 2.5.5.3
Dielectric Strength	137 kV/mm (3500 V/mil)	ASTM D-149
Insulation Resistance (at ambient)	10 ⁶ megohms	IPC-TM-650, No. 2.6.3.2
Volume Resistivity (at ambient)	10 ⁹ megohm-cm	ASTM D-257
Surface Resistance (at ambient)	10 ⁷ megohms	ASTM D-257

The values in Table 3 represent a typical 1 oz. RA copper foil, 1 mil adhesive and 1 mil Kapton® construction.



DUPONT™ PYRALUX® FR COPPER-CLAD LAMINATES

SAFE HANDLING

Pyralux® FR coverlay, sheet adhesive, and bond ply contain a B-staged adhesive. Since B-staged adhesive contains trace quantities (parts per million) of unreacted monomers, operators should take care to minimize contact.

Pyralux® FR copper-clad laminates contain fully-cured (C-staged) adhesive.

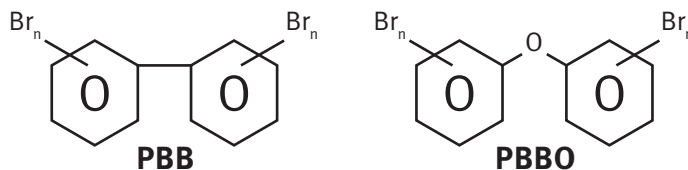
Although DuPont is not aware of anyone developing contact dermatitis when using Pyralux® FR products, some individuals may be more sensitive than others. Anyone handling Pyralux® FR products should wash their hands with soap before eating, smoking, or using restroom facilities. Gloves, finger cots, and finger pads should be changed daily. Clothes should be washed frequently.

The unreacted acrylic monomer in the adhesive may impart a mild odor when the release film or paper is removed. We recommend that areas where B-staged materials are used, as well as lay-up and lamination areas, be well-ventilated with a fresh air supply.

Pyralux® adhesive is cured during lamination. The curing reaction does not produce any vapors, although impurities may volatilize. When drilling or routing parts made with Pyralux® FR flexible composites, provide adequate vacuum around the drill head to minimize worker exposure to adhesive dust.

Thin copper-clad laminates can have sharp metal edges. People handling these materials should be cautioned and provided with suitable gloves to prevent cuts.

Pyralux® FR flexible composites DO NOT contain polybrominated biphenyls (PBBs), polybrominated biphenyl oxides (PBBOs), or polybrominated diphenyl ethers (PBDEs).



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DUPONT™ PYRALUX® FR BOND PLY

FLEXIBLE COMPOSITES

PRODUCT DESCRIPTION

DuPont™ Pyralux® FR bond ply is constructed of DuPont™ Kapton® polyimide film, coated on both sides with a proprietary, flame-retardant, B-staged acrylic adhesive. Bond ply is used to encapsulate two etched details for environmental protection and electrical insulation. Using bond ply can eliminate a layer of Kapton® and a layer of adhesive in low layer count multilayer constructions.

CONSTRUCTION

Bond ply is available in a variety of film and adhesive thicknesses. **Table 1** lists typical constructions.

The product code must be used when ordering sheet adhesive from DuPont.

PACKAGING

Pyralux® bond ply composites are supplied on 24 in (610 mm) wide by 250 ft (76 m) long rolls, on nominal 3 in (76 mm) cores. Narrower widths or cut sheets are also available by special order.

TYPICAL DATA

Each manufactured lot, except the bond ply constructions noted in **Table 1**, is certified to IPC specifications and tested according to IPC Test Method TM-650. See **Table 2**.

Table 1. Bond Ply Product Codes

Product Code	Adhesive	Kapton®	IPC
	mil (µm)	mil (µm)	Certification*
FR0111	1 (25)	1 (25)	Yes
FR0121	1 (25)	2 (51)	Yes
FR0131	1 (25)	3 (76)	Yes
FR0212	2 (51)	1 (25)	Yes
FR7021	1/2 (13)	1/2 (13)	No
FR7016	1 (25)	1/2 (13)	No
FR7081	2 (76)	1/2 (13)	No
FR1515	1/2 (13)	1 (25)	Yes

*Certified to IPC-4203/1: "Adhesive Coated Dielectric Films for Use as Cover Sheets for Flexible Printed Circuits and Flexible Adhesive Bonding Films."

Exception: The DuPont flow requirement, using IPC-TM-650, Method 2.3.17.1, is 10.0 mils/mil of adhesive thickness.

Table 2. Pyralux® FR Bond Ply Properties

Property	Typical Coverlay Value	Test Method
Flammability*	VTM-0	UL94
Meets UL746E Direct Support Requirements	Yes	UL746E
Peel Strength**	—	IPC-TM-650, No. 2.4.9
After lamination	1.6 N/mm (9 lb/in)	Method B
After soldering	1.6 N/mm (9 lb/in)	Method D
Solder Float Resistance 10 sec at 288°C (550°F)	Pass	IPC-TM-650, No. 2.4.13 Method B
Adhesive Flow, µm/µm (mil/mil)	4.0	IPC-TM-650, No. 2.3.17.1
Thickness Tolerance	±10%	IPC-TM-650, No. 4.6.2
Dimensional Stability	-0.03%	IPC-TM-650, No. 2.2.4 Method A
Dielectric Constant (at 1 MHz)	3.5	IPC-TM-650, No. 2.5.5.3
Dissipation Factor (at 1 MHz)	0.02	IPC-TM-650, No. 2.5.5.3
Dielectric Strength	137 kV/mm (3500 V/mil)	ASTM D-149
Insulation Resistance (at ambient)	10 ⁶ megohms	IPC-TM-650, No. 2.6.3.2
Volume Resistivity (at ambient)	10 ⁹ megohm-cm	ASTM D-257
Surface Resistance (at ambient)	10 ⁷ megohms	ASTM D-257

*Laminating Conditions: 14 kg/cm² (200 psi), 182°C (360°F), 1 hour to treated side of 1 oz RA copper foil.

The values in Table 2 represent a typical 1 oz. RA copper foil, 1 mil adhesive and 1 mil Kapton® construction.



DUPONT™ PYRALUX® FR BOND PLY

A Certificate of Conformance is available with every batch. Complete material and manufacturing records for each lot, with samples of finished product, are retained for reference purposes. The roll labels contain the lot number, DuPont order number, customer order number, IPC specification, customer specification, and customer part number; save these labels for reference in case of inquiries.

PROCESSING

Laminating conditions for DuPont™ Pyralux® flexible composites are typically in the following ranges:

Part Temperature: 182–199°C (360–390°F)
Pressure: 14–28 kg/cm² (200–400 psi)
Time: 1–2 hours, at temperature

Pyralux® FR can be processed like Pyralux® LF. Refer to publication “Pyralux® Flexible Composites Technical Manual” for further processing details.

STORAGE CONDITIONS AND WARRANTY

Pyralux® FR flexible laminates should be stored in the original packaging at temperatures of 4–29°C (40–85°F) and below 70% humidity. The product should not be frozen and should be kept dry, clean and well-protected. Subject to compliance with the foregoing handling and storage recommendations, DuPont’s warranties, as provided in the DuPont Standard Conditions of Sale, shall remain in effect for a period of two years following the date of shipment.

SAFE HANDLING

Pyralux® FR coverlay, sheet adhesive, and bond ply contain a B-staged adhesive. Since B-staged adhesive contains trace quantities (parts per million) of unreacted monomers, operators should take care to minimize contact.

Pyralux® FR copper-clad laminates contain fully-cured (C-staged) adhesive.

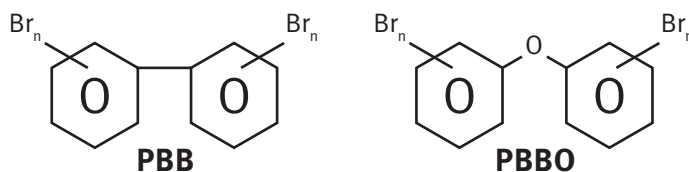
Although DuPont is not aware of anyone developing contact dermatitis when using Pyralux® FR products, some individuals may be more sensitive than others. Anyone handling Pyralux® FR products should wash their hands with soap before eating, smoking, or using restroom facilities. Gloves, finger cots, and finger pads should be changed daily. Clothes should be washed frequently.

The unreacted acrylic monomer in the adhesive may impart a mild odor when the release film or paper is removed. We recommend that areas where B-staged materials are used, as well as lay-up and lamination areas, be well-ventilated with a fresh air supply.

Pyralux® adhesive is cured during lamination. The curing reaction does not produce any vapors, although impurities may volatilize. When drilling or routing parts made with Pyralux® FR flexible composites, provide adequate vacuum around the drill head to minimize worker exposure to adhesive dust.

Thin copper-clad laminates can have sharp metal edges. People handling these materials should be cautioned and provided with suitable gloves to prevent cuts.

Pyralux® FR flexible composites DO NOT contain polybrominated biphenyls (PBBs), polybrominated biphenyl oxides (PBBOs), or polybrominated diphenyl ethers (PBDEs).



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DUPONT™ PYRALUX® FR SHEET ADHESIVE

FLEXIBLE COMPOSITES

PRODUCT DESCRIPTION

DuPont™ Pyralux® FR sheet adhesive is a proprietary, flame-retardant, B-staged modified acrylic adhesive. Sheet adhesive is used primarily to bond flexible inner layers of multilayers, as well as to bond stiffeners and heat sinks to flexible circuits and rigid boards.

CONSTRUCTION

Pyralux® FR sheet adhesive is coated on release paper and is available in a variety of adhesive thicknesses; see **Table 1**.

The product code must be used when ordering sheet adhesive from DuPont.

PACKAGING

Sheet adhesive is supplied on 24 in (610 mm) wide by 250 ft (76 m) long rolls, on nominal 3 in (76 mm) cores. Narrower widths or cut sheets are also available by special order.

Table 1. Sheet Adhesive Product Codes

Product Code	Adhesive	IPC
	mil (µm)	Certification*
FR0100	1 (25)	Yes
FR0200	2 (51)	Yes
FR0300	3 (76)	Yes
FR0400	4 (102)	Yes
FR1500	1/2 (13)	Yes
FR1700	.7 (18)	Yes

*Certified to IPC-4203/18: "Adhesive Coated Dielectric Films for Use as Cover Sheets for Flexible Printed Circuits and Flexible Adhesive Bonding Films."

Exception: The DuPont flow requirement, using IPC-TM-650, Method 2.3.17.1, is 10.0 mils/mil of adhesive thickness.

TYPICAL DATA

Each manufactured lot of sheet adhesive is certified to IPC specifications and tested according to IPC Test Method TM-650. See **Table 2**.

Table 2. Pyralux® FR Sheet Adhesive Properties

Property	Typical Coverlay Value	Test Method
Flammability*	VTM-0	UL94
Peel Strength**	—	IPC-TM-650, No. 2.4.9
After lamination	1.6 N/mm (9 lb/in)	Method B
After soldering	1.6 N/mm (9 lb/in)	Method D
Solder Float Resistance 10 sec at 288°C (550°F)	Pass	IPC-TM-650, No. 2.4.13 Method B
Adhesive Flow, µm/µm (mil/mil)	4.0	IPC-TM-650, No. 2.3.17.1
Thickness Tolerance	±10%	IPC-TM-650, No. 4.6.2
Dielectric Constance (at 1 MHz)	3.5	IPC-TM-650, No. 2.5.5.3
Dissipation Factor (at 1 MHz)	0.02	IPC-TM-650, No. 2.5.5.3
Dielectric Strength	118 kV/mm (3000 V/mil)	ASTM D-149
Insulation Resistance (at ambient)	10 ⁶ megohms	IPC-TM-650, No. 2.6.3.2
Volume Resistivity (at ambient)	10 ⁹ megohm-cm	ASTM D-257
Surface Resistance (at ambient)	10 ⁷ megohms	ASTM D-257

*Pyralux® FR0200 and FR0300 meet UL 94 VTM-0 criteria.

**Laminating Conditions: 14 kg/cm² (200 psi), 182°C (360°F), 1 hour to treated side of 1 oz RA copper foil.

The values in Table 2 represent a typical 1 oz. RA copper foil, 1 mil adhesive and 1 mil Kapton® construction.



DUPONT™ PYRALUX® FR SHEET ADHESIVE

A Certificate of Conformance is available with every batch. Complete material and manufacturing records for each lot, with samples of finished product, are retained for reference purposes. The roll labels contain the lot number, DuPont order number, customer order number, IPC specification, customer specification, and customer part number; save these labels for reference in case of inquiries.

PROCESSING

Laminating conditions for DuPont™ Pyralux® flexible composites are typically in the following ranges:

Part Temperature: 182–199°C (360–390°F)
Pressure: 14–28 kg/cm² (200–400 psi)
Time: 1–2 hours, at temperature

Pyralux® FR can be processed like Pyralux® LF. Refer to publication “Pyralux® Flexible Composites Technical Manual” for further processing details.

STORAGE CONDITIONS AND WARRANTY

Pyralux® FR flexible laminates should be stored in the original packaging at temperatures of 4–29°C (40–85°F) and below 70% humidity. The product should not be frozen and should be kept dry, clean and well-protected. Subject to compliance with the foregoing handling and storage recommendations, DuPont’s warranties, as provided in the DuPont Standard Conditions of Sale, shall remain in effect for a period of two years following the date of shipment.

SAFE HANDLING

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Pyralux® FR copper-clad laminates contain fully-cured (C-staged) adhesive.

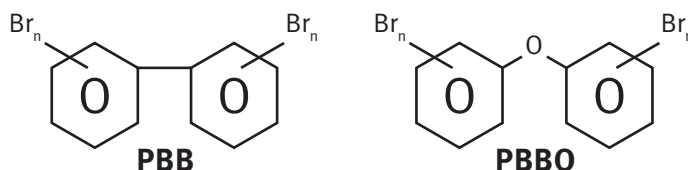
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