

DuPont™ Pyralux® LF Copper-Clad Laminates

flexible composites

Technical Information

Description

DuPont™ Pyralux® copper-clad laminated composites are constructed of DuPont™ Kapton® polyimide film with copper foil on one or both sides, bonded together with a proprietary C-staged modified acrylic adhesive. 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.

Pyralux® laminated composites are typically used to produce high reliability, high density circuitry of flexible, rigid-flex, and all-flexible multilayer constructions. Techniques commonly used in the manufacture of flexible circuits can be used to process Pyralux® composites.

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 copper-clad laminates from DuPont.

Packaging

Pyralux® copper-clad laminates are supplied in 24-inch (610 mm) by 36-inch (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**.

Table 1
Single-Sided Copper-Clad Product Codes

Product Code*	Copper	Adhesive	Kapton®	IPC
	oz/ft² (g/m²)	Mil (µm)	Mil (µm)	Cert.¹
LF9110R	1 (305)	1 (25)	1 (25)	Yes
LF9120R	1 (305)	1 (25)	2 (51)	Yes
LF9130R	1 (305)	1 (25)	3 (76)	Yes
LF9150R	1 (305)	1 (25)	5 (127)	Yes
LF9210R	2 (610)	1 (25)	1 (25)	Yes
LF9220R	2 (610)	1 (25)	2 (51)	Yes
LF7012R	1/2 (153)	1/2 (13)	1/2 (13)	No
LF7002R	1 (305)	1/2 (13)	1/2 (13)	No
LF7062R	1/2 (153)	1/2 (13)	1 (25)	No
LF7011R	1 (305)	1/2 (13)	1 (25)	Yes
LF7008R	2 (610)	1/2 (13)	1 (25)	Yes
LF7092R	1 (305)	1/2 (13)	2 (51)	Yes
LF7004R	1/2 (153)	1 (25)	1/2 (13)	No
LF7037R	1 (305)	1 (25)	1/2 (13)	No
LF7038R	2 (610)	1 (25)	1/2 (13)	No
LF8510R	1/2 (153)	1 (25)	1 (25)	Yes
LF7031R	3/4 (229)	1 (25)	1 (25)	Yes
LF8520R	1/2 (153)	1 (25)	2 (51)	Yes
LF7019R	3/4 (229)	1 (25)	2 (51)	Yes
LF7097R	1 (305)	2 (51)	1 (25)	Yes

*Add "R" to the end of the code to specify rolled-annealed copper (e.g., LF9210R). Add "E" to the end of the code to specify electro-deposited copper (e.g., LF9210E). If rolled annealed double-treated copper is specified, add the letter "D" to the end of the product code (e.g., LF9210D).

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

A Certificate of Analysis is available with every batch. Complete material and manufacturing records for each lot, with samples of finished laminate, are retained for reference purpose. 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.



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Table 2
Double-Sided Copper-Clad Product Codes

Product Code*	Copper	Adhesive	Kapton®	IPC
	oz/ft ² (g/m ²)	Mil (µm)	Mil (µm)	Cert. ¹
LF9111R	1 (305)	1 (25)	1 (25)	Yes
LF9121R	1 (305)	1 (25)	2 (51)	Yes
LF9131R	1 (305)	1 (25)	3 (76)	Yes
LF9151R	1 (305)	1 (25)	5 (127)	Yes
LF9212R	2 (610)	1 (25)	1 (25)	Yes
LF9222R	2 (610)	1 (25)	2 (51)	Yes
LF7022R	1/2 (153)	1/2 (13)	1/2 (13)	No
LF7014R	1/2 (153)	1/2 (13)	1 (25)	No
LF7010R	1 (305)	1/2 (13)	1 (25)	Yes
LF7041R	2 (610)	1/2 (13)	1 (25)	Yes
LF7091R	1/2 (153)	1/2 (13)	2 (51)	Yes
LF7093R	1 (305)	1/2 (13)	2 (51)	Yes
LF7058R	2 (610)	1/2 (13)	2 (51)	Yes
LF7003R	2 (610)	1/2 (13)	3 (76)	No
LF7017R	1/2 (153)	1 (25)	1/2 (13)	No
LF7039R	1 (305)	1 (25)	1/2 (13)	No
LF7040R	2 (610)	1 (25)	1/2 (13)	No
LF8515R	1/2 (153)	1 (25)	1 (25)	Yes
LF8525R	1/2 (153)	1 (25)	2 (51)	Yes
LF7090R	2 (610)	2 (51)	2 (51)	Yes
LF7071R	1 (305)	1/2 (13)	1/2 (13)	Yes

*Add "R" to the end of the code to specify rolled-annealed copper (e.g., LF9210R). Add "E" to the end of the code to specify electro-deposited copper (e.g., LF9210E). If rolled annealed double-treated copper is specified, add the letter "D" to the end of the product code (e.g., LF9210D).
¹Certified to IPC-4204/1: "Flexible Metal-Clad Dielectrics for use in Fabrication of Flexible Printed Wiring."

Processing

Laminating conditions for 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

For further processing information contact your DuPont representative to receive a Pyralux® Technical Manual.

Storage Conditions and Warranty

Pyralux® LF 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, the DuPont warranty, 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
Copper-Clad Laminate Properties vs IPC Specifications

Property	IPC Spec	Typical Clad Value
Peel Strength, min., lb/in (kg/cm) As received As solder	8 (1.4) 7 (1.3)	10 (1.8) 9 (1.6)
Dimensional Stability, max., percent	0.15	0.10
Dielectric Constant, max. (at 1 MHz)	4.0	3.6
Dissipation Factor, max. (at 1 MHz)	0.03	0.02
Volume Resistivity, min., megohm-cm (ambient)	10 ⁷	10 ⁹
Surface Resistivity, min., megohm-cm (ambient)	10 ⁶	10 ⁸

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

Safe Handling

Pyralux® copper-clad laminated composites are supplied in sheets and are fully cured (C-staged).

DuPont is not aware of anyone developing contact dermatitis, or suffering any other medical discomforts, when using Pyralux® products. The uncured acrylic monomers in the bond ply adhesive may impart a mild odor. However, these products have been extensively tested under operating conditions (drilling and lamination conditions) and found to liberate measurable volatiles only well below¹ accepted safe limits (e.g., PEL).

To eliminate contact between the skin and exposed adhesive after etching, wear lint-free gloves or fingerpads. Anyone handling Pyralux® should wash their hands with soap before eating, smoking, or using restroom facilities. Gloves and fingerpads should be changed daily, and wash other protective clothing frequently.

Adequate ventilation and exhaust is recommended in press rooms to prevent the buildup of potentially harmful vapors, to remove disagreeable odors, and to dissipate heat. Drill rooms should be furnished with standard equipment recommended by drill vendors and required by OSHA standards.

For further information on safe handling, refer to DuPont publication H-46873, "Pyralux® LF and FR Safe Handling;" and refer to "Industrial Ventilation," 18th Edition or latest available from the American Conference of Governmental Industrial Hygienists, 6500 Glenway, Building D-5, Cincinnati, OH 45211.

¹Values for all materials monitored were well below 10% of their accepted limits (PEL or TLV). In only one case, did the concentration reach approximately 40% of its limit. This was an oven used to dry the uncured acrylic material. This oven drying is not normally used in the process and during the exposure the oven was unventilated. Adequate ventilation is normally recommended for any heating process.

For more information on DuPont™ Pyralux® flexible circuit materials, please contact your local representative, or visit our website:

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DuPont™ Pyralux® LF Bond Ply

flexible composites

Technical Information

Description

DuPont™ Pyralux® bond ply composites are constructed of DuPont™ Kapton® polyimide film coated on both sides with a proprietary B-staged modified acrylic adhesive. Bond ply is used to encapsulate two etched details for environmental and electrical insulation. Using bond ply can eliminate a layer of Kapton® and a layer of adhesive in low 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 bond ply from DuPont.

Table 1
Bond Ply Product Codes

Product Code*	Adhesive	Kapton®	Adhesive	IPC
	Mil (µm)	Mil (µm)	Mil (µm)	Certification*
LF0111	1 (25)	1 (25)	1 (25)	Yes
LF0121	1 (25)	2 (51)	1 (25)	Yes
LF0131	1 (25)	3 (76)	1 (25)	Yes
LF0212	2 (51)	1 (25)	2 (51)	Yes
LF7021	1/2 (13)	1/2 (13)	1/2 (13)	No
LF7016	1 (25)	1/2 (13)	1 (25)	No
LF7081	2 (76)	1/2 (13)	2 (51)	No
LF1515	1/2 (13)	1 (25)	1/2 (13)	Yes

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

Packaging

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

Typical Data

Each manufactured lot, except the three 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 2
Bond Ply Properties vs IPC Specifications

IPC Property	Coverlay Spec	Typical Value
Peel Strength, min., lb/in (kg/cm) As received After solder	8 (1.4) 7 (1.3)	10 (1.8) 9 (1.6)
Dimensional Stability, max., percent	0.10	+0.03
Adhesive Flow, max. mil/mil adhesive (µm/µm)	5.0 (127)	2-4 (51-102)
Dielectric Constant, max. (at 1 MHz)	4.0	3.6
Dissipation Factor, max. (at 1 MHz)	0.03	0.02
Volume Resistivity, min., megohm-cm (ambient)	10 ⁷	10 ⁹
Surface Resistivity, min., megohm-cm (ambient)	10 ⁶	10 ⁸

*Laminating Conditions: 14kg/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 copper foil, 1 mil adhesive and 1 mil Kapton® construction.

A Certificate of Analysis is available with every batch. Complete material and manufacturing records for each lot, with samples of finished laminate, are retained for reference purpose. 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 Pyralux® flexible composites are typically in the following ranges:

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

For further processing information contact your DuPont representative to receive a Pyralux® Technical Manual.



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Storage Conditions and Warranty

DuPont™ Pyralux® LF 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® bond ply composites contain a B-staged adhesive. Because B-staged adhesive contains trace quantities (parts per million) of unreacted monomers, precautions and recommendations should be taken to minimize contact.

DuPont is not aware of anyone developing contact dermatitis, or suffering any other medical discomforts, when using Pyralux® products. The uncured acrylic monomers in the bond ply adhesive may impart a mild odor. However, these products have been extensively tested under operating conditions (drilling and lamination conditions) and found to liberate measurable volatiles only well below¹ accepted safe limits (e.g., PEL).

To eliminate contact between the skin and the adhesive, wear lint-free gloves or fingerpads. Anyone handling Pyralux® should wash their hands with soap before eating, smoking, or using restroom facilities. Gloves and fingerpads should be changed daily, and wash other protective clothing frequently.

Adequate ventilation and exhaust is recommended in press rooms to prevent the buildup of potentially harmful vapors, to remove disagreeable odors, and to dissipate heat. Drill rooms should be furnished with standard equipment recommended by drill vendors and required by OSHA standards.

For further information on safe handling, refer to DuPont publication H-46873, "Pyralux® LF and FR Safe Handling;" and refer to "Industrial Ventilation," 18th Edition or latest available from the American Conference of Governmental Industrial Hygienists, 6500 Glenway, Building D-5, Cincinnati, OH 45211.

¹Values for all materials monitored were well below 10% of their accepted limits (PEL or TLV). In only one case, did the concentration reach approximately 40% of its limit. This was an oven used to dry the uncured acrylic material. This oven drying is not normally used in the process and during the exposure the oven was unventilated. Adequate ventilation is normally recommended for any heating process.

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This information may be subject to revision as new knowledge and experience become available. This publication is not to be taken as a license to operate under, or recommendation to infringe, any patent.





DUPONT™ PYRALUX® LF SHEET ADHESIVE

FLEXIBLE COMPOSITES

DESCRIPTION

Sheet adhesive in the DuPont™ Pyralux® product line is a proprietary B-staged modified acrylic adhesive coated on release paper. Sheet adhesive is used primarily to bond flexible innerlayers or rigid cap layers in multilayer lamination. It is also widely used to bond flexible circuits to rigid boards during the fabrication of rigid-flex circuits, as well as to bond stiffeners and heat sinks.

CONSTRUCTION

Sheet adhesive is available in a variety of thicknesses; see **Table 1**. The product code must be used when ordering sheet adhesive from DuPont.

Table 1 - Sheet Adhesive Product Codes

Product Code*	Adhesive Mil (μm)	IPC Certification*
LF0100	1 (25)	Yes
LF0200	2 (51)	Yes
LF0300	3 (76)	Yes
LF0400	4 (102)	Yes
LF1500	1/2 (13)	Yes
LF1700	.7 (18)	Yes
LF1800	.8 (20)	Yes
LF7049	1.5 (38)	Yes

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

PACKAGING

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

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 - Sheet Adhesive Properties vs IPC Specifications

Adhesive Property	IPC Spec	Typical Sheet Value
Peel Strength*, min., lb/in (kg/cm) As received After solder	8 (1.4) 7 (1.3)	10 (1.8) 9 (1.6)
Solder Resistance 10 sec at 288°C (550°F)	Pass	Pass
Adhesive Flow, max. mil/mil adhesive (μm/μm)	5.0 (127)	2–4 (51–102)
Dielectric Constant, max. (at 1 MHz)	4.0	3.6–4.0
Dissipation Factor, max. (at 1 MHz)	0.05	0.02–0.03
Dielectric Strength volts/mil (kV/mm)	1,000 40	2,000–3,000 80–120
Insulation Resistance megohm	10 ⁴	10 ⁵
Volume Resistivity, min., megohm-cm (ambient)	10 ⁷	10 ⁹
Surface Resistivity, min., megohm-cm (ambient)	10 ⁶	10 ⁸

*Laminating Conditions: 14kg/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 copper foil, 1 mil adhesive and 1 mil Kapton® construction.

A Certificate of Analysis is available with every batch. Complete material and manufacturing records for each lot, with samples of finished laminate, are retained for reference purpose. 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 Pyralux® flexible composites are typically in the following ranges:

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

For further processing information contact your DuPont representative to receive a Pyralux® Technical Manual.



DUPONT™ PYRALUX® LF SHEET ADHESIVE

STORAGE CONDITIONS AND WARRANTY

DuPont™ Pyralux® LF Sheet Adhesives 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, the DuPont warranty, 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® sheet adhesive contains a B-staged adhesive. Because B-staged adhesive contains trace quantities (parts per million) of unreacted monomers, precautions and recommendations should be taken to minimize contact.

DuPont is not aware of anyone developing contact dermatitis, or suffering any other medical discomforts, when using Pyralux® products. The uncured acrylic monomers in the bond ply adhesive may impart a mild odor. However, these products have been extensively tested under operating conditions (drilling and lamination conditions) and found to liberate measurable volatiles only well below¹ accepted safe limits (e.g., PEL).

To eliminate contact between the skin and the adhesive, wear lint-free gloves or fingerpads. Anyone handling Pyralux® should wash their hands with soap before eating, smoking, or using restroom facilities. Gloves and fingerpads should be changed daily, and wash other protective clothing frequently.

Adequate ventilation and exhaust is recommended in press rooms to prevent the buildup of potentially harmful vapors, to remove disagreeable odors, and to dissipate heat. Drill rooms should be furnished with standard equipment recommended by drill vendors and required by OSHA standards.

For further information on safe handling, refer to DuPont publication H-46862, “Pyralux® LF and FR Safe Handling;” and refer to “Industrial Ventilation,” 18th Edition or latest available from the American Conference of Governmental Industrial Hygienists, 6500 Glenway, Building D-5, Cincinnati, OH 45211.

¹Values for all materials monitored were well below 10% of their accepted limits (PEL or TLV). In only one case, did the concentration reach approximately 40% of its limit. This was an oven used to dry the uncured acrylic material. This oven drying is not normally used in the process and during the exposure the oven was unventilated. Adequate ventilation is normally recommended for any heating process.

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

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