

## Microwave Substrates

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Polyflon has taken advantage of the qualities of PTFE and coupled them with a proprietary plating process to produce a microwave substrate whose electrical performance cannot be equaled by any other substrate at this time.

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Polyflon's NorCLAD laminates, made from the thermoplastic PPO (Polyphenylene Oxide), have an ideal dielectric constant of 2.55, very uniform and reproducible electrical properties, and are stable over temperature.

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Polyguide clad laminates and dielectrics are precision fabricated from the highest quality, high-density polyolefin available. Irradiation cross-linking of the polyolefin permanently imparts improved electrical homogeneity and mechanical toughness, while significantly enhancing the temperature and chemical resistance of the material. These laminates are impervious to solvents and solutions used in microwave circuit processing and fabrication.

### **Copper-Clad ULTEM®**

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Polyflon had added another microwave laminate to its product list. Polyflon's Copper-Clad ULTEM® laminates, made from the engineering amorphous thermoplastic PEI (Polyetherimide), have isotropic electrical and mechanical properties with exceptional thermal stability. The specific gravity of 1.27 is significantly less than that of competitive PTFE/Glass material. ULTEM® is a registered trademark of General Electric.

### **Bonding Films**

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Polyflon Bonding Film is a thermally stabilized, irradiated polyolefin co-polymer developed for bonding single or multi-layer microwave strip-line circuit boards fabricated from POLYGUIDE clad laminates.



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## CuFlon<sup>®</sup> Microwave Substrates

Polyflon has taken advantage of the qualities of PTFE and coupled them with a proprietary plating process to produce a microwave substrate whose loss performance cannot be equaled by any other substrate available at this time.

PTFE has unique electrical and physical properties: low loss tangent and dissipation factor, very low dielectric constant, high volume and surface resistivity, high chemical inertness, and almost zero water absorption.

- |                              |                        |                 |                        |
|------------------------------|------------------------|-----------------|------------------------|
| <b>Features and Benefits</b> | • Ultra Low Loss       | • Very Low Dk   | • Isotropic Properties |
| <b>Typical Applications</b>  | • High Power Amplifier | • NRM/MRI Coils | • Couplers             |

Property	Value	Units	Direction	Frequency	Test Method/Condition
Dielectric Constant	2.05 +/- .05	-	Z	18 GHz	IPC-TM-650
Dissipation Factor	0.00045	-	Z	18 GHz	IPC-TM-650
Dielectric Strength (0.020")	1000	V/mil	Z	-	ASTM D 149
Volume Resistivity	10 <sup>16</sup>	ohm • cm	Z	-	ASTM D 257
Maximum Temperature	225	°C	-	-	Short Duration
Thermal Conductivity	0.25	W/m/°C	Z	-	ASTM C 518
Specific Gravity	2.15	-	-	-	ASTM D 792
Thermal Expansion	129	ppm/°C	X	-	ASTM E 831
(Unclad Dielectric)	129	ppm/°C	Y	-	ASTM E 831
	129	ppm/°C	Z	-	ASTM E 831
Water Absorption	<.01	%	-	-	ASTM D 570
Copper Peel (Average)	6-8	lbs/in	-	-	
Operating Temperature	-55 to 175	°C	-	-	
RoHS Compliant	Yes	Compliance Statement Available Upon Request			

<i>Panel Sizes for Various Standard Dielectric Thickness'</i>	
9" x 9" Panel	12" x 18" Panel
0.00025" (6µm)	0.010" (.25 mm)
0.0005" (13µm)	0.015" (.38 mm)
0.001" (25µm)	0.020" (.51 mm)
0.002" (51µm)	0.031" (.79 mm)
0.003" (76µm)	0.062" (1.57 mm)
0.005" (127µm)	0.125" (3.18 mm)

<i>Standard Copper weight/thickness</i>
1/8 oz/ft <sup>2</sup> (4 µm)
1/4 oz/ft <sup>2</sup> (9 µm)
1/2 oz/ft <sup>2</sup> (18 µm)
1 oz/ft <sup>2</sup> (35 µm)
2 oz/ft <sup>2</sup> (70 µm)
Other Available on Request

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CuFlon<sup>®</sup> is a registered trademark of Polyflon Company

# CRANE POLYFLON

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## CuFlon Pure PTFE Substrates Machining Guidelines

### **General Principals for Drilling**

CuFlon is a microwave material consisting of PURE Teflon® resin electroplated with copper using a process developed by Polyflon. Longer tool life can be expected when drilling CuFlon than glass-reinforced laminates. It is suggested that, for consistent results, high-grade carbide tools be used. Although tool wear is minimal when drilling CuFlon, it is suggested that an examination under a microscope for tool edge wear and edge chips be done on new tools and should also be conducted after 500 hits (depending on drill diameter, laminate thickness and stack height). The edges of the tools must be kept sharp. A dull tool can produce a hole whose wall is scored and has been over-heated rendering the plating on the wall unacceptable.

### **Drilling Parameters:**

Smooth, burr-free holes can be drilled in CuFlon by following a few standard precautions.

- Use backup material that has a hard outer layer with a paper or wood resin inner. The backup material should be between .093 and .125 thick. A paper-phenolic material is suggested. The entry material should be between .012 and .025 inch thick phenolic.
- Do NOT use aluminum for entry material.
- Do not drill any deeper than is necessary.
- Several CuFlon laminates may be drilled in a stack if drill size and location tolerance allow, however, it is suggested that a sheet of entry material be placed between the laminates.
- Maintain adequate drill foot pressure on the stack during drilling to minimize burr formation.

### **Routing Parameters:**

CuFlon materials are very easy to cut to final shape by punch and die, steel rule die or routing with a carbide end mill. The tolerances, edge smoothness requirements and panel thickness determine the final fabrication method. It is suggested that CNC routing be used for thickness over .020 and where cutting thru copper is a requirement.

- Router bit selection is important. Carbide single or two fluted up cut end mills should be used.
- Routing should be done utilizing a backup material that has a hard outer layer with a paper or wood resin inner. The backup material should be between .093 and .125 thick. A paper-phenolic material is suggested. The entry material should be between .015 and .025 inch thick phenolic
- Rough-cuts and final cuts along inside edges should be made clockwise, while outside edges should be made counter-clockwise.
- The tool surface speed should be kept to 150 feet/min.
- Do not exceed .025 inch depth into the backup material
- Do NOT use aluminum for entry material.

The information contained in this guide is intended to aid in the processing of CuFlon material. There are no warranties, expressed or implied, including warranty of merchantability for a particular application.

Revised 03JAN02



## NorCLAD™ Microwave Laminates

Polyflon's NorCLAD Laminates, made from a modified version of the thermoplastic PPO (Polyphenylene Oxide), have an ideal dielectric constant of 2.55, very uniform and reproducible electrical properties, and are very stable over temperature.

When first introduced in the early 1960s PPO was touted as the ultimate dielectric for use as a microwave laminate. However, as a circuit board material, its usage was limited due to the solvent based processing chemicals used at the time. Polyflon's NorCLAD, being impervious to today's aqueous processing chemicals is ideal for RF and Microwave applications, at a price well below materials offering comparable performance.

- |                              |            |            |                     |                        |
|------------------------------|------------|------------|---------------------|------------------------|
| <b>Features and Benefits</b> | • Low Loss | • Low Cost | • Thermal Stability | • Isotropic Properties |
| <b>Typical Applications</b>  | • GPS      | • UAV      | • SatCom Subscriber | • Broadband ComLink    |

Property	Value	Units	Direction	Frequency	Test Method/Condition
Dielectric Constant	2.55 +/- .05	-	Z	3GHz	IPC-TM-650
Dissipation Factor	0.0011	-	Z	3GHz	IPC-TM-650
Dielectric Strength (0.125")	500	V/mil	Z	-	ASTM D 149
Volume Resistivity	10 <sup>17</sup>	ohm • cm	Z	-	ASTM D 257
Maximum Temperature	175	°C	-	-	Short Duration
Thermal Conductivity	.23	W/m/°C	Z	-	ASTM C 518
Specific Gravity	1.12	-	-	-	ASTM D 792
Thermal Expansion	53	ppm/°C	X	-	ASTM E 831
(Unclad Dielectric)	53	ppm/°C	Y	-	ASTM E 831
	53	ppm/°C	Z	-	ASTM E 831
Water Absorption	0.06-0.07	%	-	-	ASTM D 570
Copper Peel (Average)	6-8	lbs/in	-	-	
Operating Temperature	-55 to 125	°C	-	-	
RoHS Compliant	Yes	Compliance Statement Available Upon Request			
Color, Dielectric	Black				

### NorCLAD Ordering Information

Dielectric Thickness	Panel Size	Copper Weight/Thickness
0.060" (1.524mm)	20" x 22" (508 x 559mm)	½ oz/ft <sup>2</sup> (17 microns) 1 oz/ft <sup>2</sup> (35 microns) 2 oz/ft <sup>2</sup> (70 microns)
0.090" (2.286mm)		
0.125" (3.175mm)		
0.250" (6.350mm)		
0.375" (9.525mm)		
0.500" (12.70mm)		

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NorCLAD® is a trademark of Polyflon Company



## POLYGUIDE™ Microwave Laminates

POLYGUIDE Laminates are manufactured from an irradiated polyolefin which combine low loss and low cost to produce a superior laminate that is ideal for commercial antenna applications. The irradiation process permanently imparts improved electrical homogeneity and mechanical toughness while significantly enhancing the temperature and chemical resistance properties.

- |                              |                       |               |                             |
|------------------------------|-----------------------|---------------|-----------------------------|
| <b>Features and Benefits</b> | • Low Cost            | • Low Loss    | • High Thermal Conductivity |
| <b>Typical Applications</b>  | • Commercial Antennas | • CPE Antenna | • Couplers                  |

Property	Value	Units	Direction	Frequency	Test Method/Condition
Dielectric Constant (Cu Clad)	2.320 +/- .005	-	Z	10 GHz	IPC-TM-650
Dissipation Factor	0.0005	-	Z	10 GHz	IPC-TM-650
Dielectric Strength (0.020")	500	V/mil	Z	-	ASTM D 149
Volume Resistivity	10 <sup>16</sup>	ohm • cm	Z	-	ASTM D 257
Maximum Temperature	125	°C	-	-	Short Duration
Thermal Conductivity	.51	W/m/°C	Z	-	ASTM C 518
Specific Gravity	.95	-	-	-	ASTM D 792
Thermal Expansion	108	ppm/°C	X	-	ASTM E 831
(Unclad Dielectric)	108	ppm/°C	Y	-	ASTM E 831
	108	ppm/°C	Z	-	ASTM E 831
Water Absorption	<.01	%	-	-	ASTM D 570
Copper Peel (Average)	4-6	lbs/in	-	-	
Operating Temperature	-55 to 85	°C	-	-	
RoHS Compliant	Yes	Compliance Statement Available Upon Request			

### Polyguide Ordering Information

Dielectric Thickness	Panel Size	Copper Weight/Thickness
0.031" (0.787mm) 0.062" (1.575mm) 0.125" (3.175mm) 0.187" (4.750mm) 0.250" (6.350mm)	22.5" x 32" (572mm x 813mm)	½ oz/ft <sup>2</sup> (17 microns) 1 oz/ft <sup>2</sup> (35 microns) 2 oz/ft <sup>2</sup> (70 microns)

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POLYGUIDE® is a trademark of Polyflon Company



## Copper Clad ULTEM® Microwave Laminates

Polyflon's Copper Clad ULTEM Laminates are made from PEI (Polyetherimide), an engineering amorphous thermoplastic. They have isotropic electrical and mechanical properties with good thermal stability. The copper is bonded directly to the dielectric material without adhesives.

ULTEM is used for very specific niche applications such as non-multilayer antennas.

- Features and Benefits**
- Thermally Stable
  - Isotropic Properties
  - High Temperature Performance

Property	Value	Units	Direction	Frequency	Test Method/Condition
Dielectric Constant	3.05	-	Z	3GHz	IPC-TM-650
Dissipation Factor	0.003	-	Z	3GHz	IPC-TM-650
Dielectric Strength (0.062")	830	V/mil	Z	-	ASTM D 149
Volume Resistivity	6.7 10 <sup>17</sup>	ohm • cm	Z	-	ASTM D 257
Maximum Temperature	225	°C	-	-	Short Duration
Thermal Conductivity	0.22	W/m/°C	Z	-	ASTM C 518
Specific Gravity	1.27	-	-	-	ASTM D 792
Thermal Expansion	56	ppm/°C	X	-	ASTM E 831
(Unclad Dielectric)	56	ppm/°C	Y	-	ASTM E 831
	56	ppm/°C	Z	-	ASTM E 831
Water Absorption	.25	%	-	-	ASTM D 570
Copper Peel (Average)	6-8	lbs/in	-	-	
Operating Temperature	-55 to 175	°C	-	-	
RoHS Compliant	Yes	Compliance Statement Available Upon Request			
Color, Dielectric	Amber				

### Copper Clad ULTEM Ordering Information

Dielectric Thickness	Panel Size	Copper Weight/Thickness
0.035" (0.889mm)	12" x 18" (305mm x 457mm)	½ oz/ft <sup>2</sup> (17 microns)
0.062" (1.575mm)		1 oz/ft <sup>2</sup> (35 microns)
0.125" (3.175mm)		2 oz/ft <sup>2</sup> (70 microns)

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ULTEM® is a registered trademark of General Electric



## Polyflon Bonding Film

Polyflon Bonding Film is a thermally stabilized, irradiated polyolefin co-polymer developed to achieve excellent bond strength with *low-flow* characteristics. The film can be used for fabricating strip-line circuits using most of today's microwave/RF laminate materials. The low bonding temperature is ideal for temperature critical materials/applications.

- Features and Benefits**
- Low Dk
  - Low Loss
  - Low Flow

Property	Value	Units	Direction	Frequency	Test Method/Condition
Thickness	.002	Inches			
Dielectric Constant	2.34	-		9.5 GHz	ASTM D-150
Dissipation Factor	.002	-		9.5 GHz	ASTM D-150
Dielectric Strength (0.002")	1000	V/mil	Z	-	ASTM D 149
Volume Resistivity	10 <sup>16</sup>	ohm • cm	Z	-	ASTM D 257
Tensile Strength	3000 min	psi			ASTM D-882
Elongation	300 min	%			ASTM D-882
Specific Gravity	2.15	-	-	-	ASTM D 792
Density	0.929	gm/cm <sup>3</sup>			ASTM D-1052
Color	Translucent				
Water Absorption	<.01	%	-	-	ASTM D 570
RoHS Compliant	Yes	Compliance Statement Available Upon Request			

### Bonding Technique

1. The boards to be bonded must be clean and free from skin oils, dust and foreign matter. The dielectric surfaces should be primed with appropriate commercial preparations (e.g. Use a sodium etch treatment such as Tetra Etch to prepare PTFE based boards). Copper surfaces can be cleaned using a scrubber, however, do not make contact with primed surfaces.
2. Place bonding film between boards to be laminated. A thermocouple is recommended at the bondline.
3. Place in hot press at 100-125 psi and raise temperature of bondline to 250-300°F.
4. Hold under pressure for 6-10 minutes.
5. Cool under pressure to less than 100°F before removing from press.

Polyflon Bonding Film Ordering Information		
Thickness	Sheet Size*	Part Number
0.002" (51µm)	24" x 36" (610mm x 914mm)	PPBF-200

\*Also available in roll form. Contact us for details

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