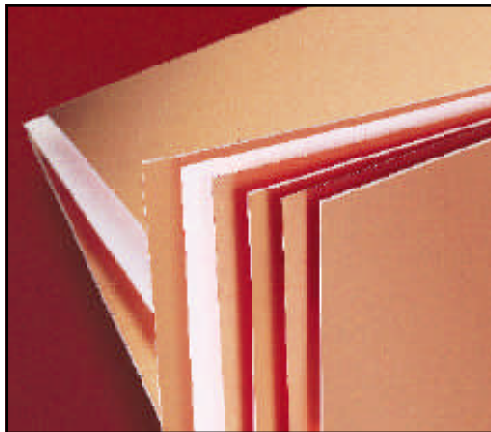




Advanced Circuit Materials



## High Frequency Circuit Materials Product Selector Guide



The world runs better with Rogers.

# High Frequency Circuit Materials - Properties

| Product                 | Composition                         | Dielectric Constant $\epsilon_r^{(1)}$<br>Tolerance @ 10GHz | Dissipation Factor TAN $\delta$<br>@ 10 GHz | Thermal <sup>(2)</sup> Coefficient of $\epsilon_r$<br>-50° - 150°C<br>(Typical) | Volume Resistivity Mohm cm<br>(Typical) | Surface Resistivity Mohm<br>(Typical) | Youngs Modulus <sup>(3)</sup><br>kpsi (MPa)<br>(Typical) |                     |                  | Moisture <sup>(4)</sup> Absorption D24/23%<br>(Typical) | Thermal Conductivity W/m <sup>2</sup> /K<br>(Typical) | Coefficient of thermal Expansion<br>0-100°C<br>(Typical) |     |     | Density gm/cm <sup>3</sup><br>(Typical) | Peel Strength lbs/in<br>(N/mm)<br>(Typical) | Flammability Rating | Standard Thickness in. (mm)   |
|-------------------------|-------------------------------------|---|---|---|---|---------------------------------------|--|---------------------|------------------|---|---|--|-----|-----|---|---|---------------------|---|
|                         |                                     |   |   |   |   |                                       | X  | Y                   | Z                |   |   | X  | Y   | Z   |   |   |                     |   |
| RT/duroid® 5870         | PTFE Glass Fiber                    | 2.33 ± 0.020  | 0.0012                                      | -115  | 2X10 <sup>7</sup>                       | 2X10 <sup>8</sup>                     | 189<br>(1,340)   | 185<br>(1,277)      | 120<br>(828)     | 0.015   | 0.22  | 22   | 28  | 173 | 2.2                                     | 20.8<br>(3.7)                               | UL 94V-0            | 0.005", (0.127mm)<br>0.010", (0.254mm)<br>0.015", (0.381mm)<br>0.020", (0.508mm)<br>0.031", (0.787mm)<br>0.062", (1.575mm)<br>0.125", (3.175mm) |
| RT/duroid® 5880         | PTFE Glass Fiber                    | 2.20 ± 0.020  | 0.0009                                      | -125  | 2X10 <sup>7</sup>                       | 3X10 <sup>7</sup>                     | 156<br>(1,076)   | 125<br>(863)        | 136<br>(938)     | 0.015   | 0.20  | 31   | 48  | 237 | 2.2                                     | 22.8<br>(4.0)                               | UL 94V-0            | 0.005", (0.127mm)<br>0.010", (0.254mm)<br>0.015", (0.381mm)<br>0.020", (0.508mm)<br>0.031", (0.787mm)<br>0.062", (1.575mm)<br>0.125", (3.175mm) |
| ULTRALAM® 2000          | PTFE Woven Glass                    | 2.40-2.60 ± 0.040   | 0.0019                                      | -100  | 2X10 <sup>7</sup>                       | 4X10 <sup>7</sup>                     | 1,700<br>(11,730)  | 1,300<br>(8,970)    |                  | 0.03  | 0.24  | 15   | 15  | 200 | 2.2                                     | 18.0<br>(3.2)                               | UL 94V-0            | 0.004", (0.101mm)<br>0.0101", (0.256mm)<br>0.0147", (0.373mm)<br>0.0190", (0.482mm)<br>0.030", (0.762mm)<br>0.060", (1.524mm)                   |
| RT/duroid® 6002         | PTFE Ceramic                        | 2.94 ± 0.040  | 0.0012                                      | +12   | 10 <sup>6</sup>                         | 10 <sup>7</sup>                       | 120<br>(828)   | 120<br>(828)        | 360*<br>(2,482)  | 0.1   | 0.60  | 16   | 16  | 24  | 2.1                                     | 8.9<br>(1.6)                                | UL 94V-0            | 0.005", (0.127mm)<br>0.010", (0.254mm)<br>0.020", (0.508mm)<br>0.030", (0.762mm)<br>0.060", (1.524mm)<br>0.120", (3.048mm)                      |
| RT/duroid® 6006         | PTFE Ceramic                        | 6.15 ± 0.150  | 0.0019                                      | -410  | 2X10 <sup>7</sup>                       | 7X10 <sup>7</sup>                     | 75<br>(511)  | 91<br>(628)         | 155<br>(1,070)   | 0.05  | 0.49  | 47   | 34  | 117 | 2.7                                     | 14.3<br>(2.5)                               | UL 94V-0            | 0.010", (0.254mm)<br>0.025", (0.635mm)<br>0.050", (1.270mm)<br>0.075", (1.905mm)<br>0.100", (2.540mm)   |
| RT/duroid® 6010LM       | PTFE Ceramic                        | 10.2 ± 0.250  | 0.0023                                      | -425  | 5X10 <sup>6</sup>                       | 5X10 <sup>6</sup>                     | 135<br>(932)   | 81<br>(559)         | 311<br>(2,146)   | 0.05  | 0.78  | 24   | 24  | 24  | 3.1                                     | 12.3<br>(2.5)                               | UL 94V-0            | 0.010", (0.254mm)<br>0.025", (0.635mm)<br>0.050", (1.270mm)<br>0.075", (1.905mm)<br>0.100", (2.540mm)   |
| TMM®3                   | Hydrocarbon Ceramic                 | 3.27 ± 0.032  | 0.0020                                      | <sup>(4)</sup> +39  | 3X10 <sup>9</sup>                       | >9X10 <sup>9</sup>                    | 1,916<br>(13,210)  | 1,916<br>(13,210)   | 742<br>(5,116)   | <sup>(4)</sup> 0.04                                     | 0.70  | 16   | 16  | 20  | 1.78                                    | 5.7<br>(1.0)                                | N/A                 | 0.015", (0.381mm)<br>0.020", (0.508mm)<br>0.030", (0.762mm)<br>0.060", (1.524mm)<br>0.125", (3.175mm)   |
| TMM®4                   | Hydrocarbon Ceramic                 | 4.50 ± 0.045  | 0.0020                                      | +15.3*  | 6X10 <sup>8</sup>                       | 1X10 <sup>9</sup>                     | 2,000*<br>(13,790)                                       | 2,000*<br>(13,790)  | 752<br>(5,185)   | <sup>(4)</sup> 0.010                                    | 0.70  | 14   | 14  | 20  | 2.07                                    | 5.7<br>(1.0)                                | N/A                 | 0.015", (0.381mm)<br>0.020", (0.508mm)<br>0.030", (0.762mm)<br>0.060", (1.524mm)<br>0.125", (3.175mm)   |
| TMM®6                   | Hydrocarbon Ceramic                 | 6.00 ± 0.080  | 0.0023                                      | <sup>(4)</sup> -10  | 1X10 <sup>8</sup>                       | 1X10 <sup>9</sup>                     | 2,200<br>(15,168)  | 2,200<br>(15,168)   | 736<br>(5,075)   | <sup>(4)</sup> 0.06                                     | 0.72  | 16   | 16  | 20  | 2.37                                    | 5.7<br>(1.0)                                | N/A                 | 0.015", (0.381mm)<br>0.025", (0.635mm)<br>0.050", (1.270mm)<br>0.075", (1.905mm)<br>0.100", (2.540mm)<br>0.125", (3.175mm)                      |
| TMM®10                  | Hydrocarbon Ceramic                 | 9.20 ± 0.230  | 0.0023                                      | <sup>(4)</sup> -38  | 2X10 <sup>8</sup>                       | 4X10 <sup>7</sup>                     | 2,400<br>(16,547)  | 2,400<br>(16,457)   | 575<br>(3,964)   | <sup>(4)</sup> 0.09                                     | 0.76  | 16   | 16  | 20  | 2.77                                    | 5.0<br>(0.9)                                | N/A                 | 0.015", (0.381mm)<br>0.025", (0.635mm)<br>0.050", (1.270mm)<br>0.075", (1.905mm)<br>0.100", (2.540mm)<br>0.125", (3.175mm)                      |
| TMM®10I                 | Hydrocarbon Ceramic                 | 9.80 ± 0.245  | 0.0020                                      | <sup>(4)</sup> -43  | 2X10 <sup>8</sup> *                     | 4X10 <sup>7</sup> *                   | 2,400*<br>(16,547)*                                      | 2,400*<br>(16,457)* | 575*<br>(3,964)* | <sup>(4)</sup> 0.16                                     | 0.76  | 16*  | 16* | 20* | 2.77                                    | 5.0<br>(0.9)                                | N/A                 | 0.015", (0.381mm)<br>0.025", (0.635mm)<br>0.050", (1.270mm)<br>0.075", (1.905mm)<br>0.100", (2.540mm)<br>0.125", (3.175mm)                      |
| RO4003C®                | Hydrocarbon Ceramic                 | 3.38 ± 0.05   | 0.0027                                      | +40   | 1.7X10 <sup>10</sup>                    | 4.2X10 <sup>9</sup>                   | 3,700<br>(25,510)  | 3,900<br>(26,889)   |                  | 0.06  | 0.64  | 11   | 14  | 46  | 1.8                                     | 6.4<br>(1.1)                                | N/A                 | 0.008", (0.203mm)<br>0.020", (0.508mm)<br>0.032", (0.813mm)<br>0.060", (1.524mm)  |
| <sup>(8)</sup> RO4350B® | Hydrocarbon Ceramic                 | 3.48 ± 0.05   | 0.004                                       | +50   | 1.2X10 <sup>10</sup>                    | 5.7X10 <sup>9</sup>                   |  | 1,664<br>(11,473)   |                  | 0.06  | 0.62  | 14   | 16  | 50  | 1.9                                     | 5.3<br>(0.9)                                | UL 94V-0            | 0.004", (0.101mm)<br>0.0066", (0.168mm)<br>0.010", (0.254mm)<br>0.020", (0.508mm)<br>0.030", (0.762mm)<br>0.060", (1.524mm)                     |
| RO4450B®                | Hydrocarbon Ceramic Prepreg         | 3.54 ± 0.05   | 0.004                                       |   |   |                                       |  |                     |                  | 0.05  | 0.60  |  |     | 60  | 1.86                                    |   | UL 94V-0            | 0.004" (0.101mm)  |
| RO3003®                 | PTFE/Ceramic                        | <sup>(7)</sup> 3.00 ± 0.04                                  | 0.0013                                      | 13  | 10 <sup>7</sup>                         | 10 <sup>7</sup>                       | 300<br>(2,068)   | 300<br>(2,068)      |                  | <0.1  | 0.50  | 17   | 17  | 24  | 2.1                                     | 17.6<br>(3.1)                               | UL 94V-0            | 0.010", (0.254mm)<br>0.020", (0.508mm)<br>0.030", (0.762mm)<br>0.060", (1.524mm)  |
| RO3203®                 | PTFE/Ceramic Reinforced Woven Glass | <sup>(7)</sup> 3.02 ± 0.04                                  | 0.0016                                      | 13  | 10 <sup>7</sup>                         | 10 <sup>7</sup>                       |  |                     |                  | <0.1  | 0.50  | 13   | 13  | 58  | 2.1                                     | 10<br>(1.7)                                 | UL 94V-0            | 0.010", (0.254mm)<br>0.020", (0.508mm)<br>0.030", (0.762mm)<br>0.060", (1.524mm)  |
| RO3006®                 | PTFE/Ceramic                        | 6.15 ± 0.15   | 0.0020                                      | -160  | 10 <sup>3</sup>                         | 10 <sup>3</sup>                       | 300<br>(2,068)   | 300<br>(2,068)      |                  | <0.1  | 0.61  | 17   | 17  | 24  | 2.6                                     | 12.2<br>(2.1)                               | UL 94V-0            | 0.010", (0.254mm)<br>0.025", (0.635mm)<br>0.050", (1.270mm)   |
| RO3010®                 | PTFE/Ceramic                        | 10.2 ± 0.30   | 0.0023                                      | -280  | 10 <sup>3</sup>                         | 10 <sup>3</sup>                       | 300<br>(2,068)   | 300<br>(2,068)      |                  | <0.1  | 0.66  | 17   | 17  | 24  | 3.0                                     | 13.4<br>(2.4)                               | UL 94V-0            | 0.010", (0.254mm)<br>0.025", (0.635mm)<br>0.050", (1.270mm)   |
| RO3210®                 | PTFE/Ceramic Reinforced Woven Glass | 10.2 ± 0.50   | 0.0027                                      |   | 10 <sup>4</sup>                         | 10 <sup>4</sup>                       |  |                     |                  | <0.1  | 0.81  | 13   | 13  | 34  | 3.0                                     | 13.4<br>(2.4)                               | UL 94V-0            | 0.025", (0.635mm)<br>0.050", (1.270mm)  |

## Metal Claddings

| Copper Foil                    | Surface Roughness     |                            | Tensile Strength kpsi (MPa) | Elongation %                | Stress Crack Resistance | Thickness mil                            |   |
|--------------------------------|-----------------------|----------------------------|-----------------------------|-----------------------------|-------------------------|--|---|
|                                | Treated Side min (mm) | Untreated Side min (mm)    |                             |                             |                         |  |   |
| ¼ oz ( 9µm) Electrodeposited   | 70<br>(1.8)           | 15<br>(0.4)                |                             |                             | Fair                    | 0.4                                      |   |
| ½ oz (17.5µm) Electrodeposited | 75<br>(1.9)           | 15<br>(0.4)                | 33.0<br>(228)               | 20.0                        | Fair                    | 0.7                                      |   |
| 1 oz. (35 µm) Electrodeposited | 95<br>(2.4)           | 15<br>(0.4)                | 30.0<br>(207)               | 28.0                        | Fair                    | 1.4                                      |   |
| 2 oz. (70 µm) Electrodeposited | 115<br>(2.9)          | 15<br>(0.4)                | 32.0<br>(221)               | 42.0                        | Fair                    | 2.8                                      |   |
| ½ (17.5 µm) Rolled             | 55<br>(1.4)           | 12<br>(0.3)                | 20.0<br>(138)               | 8.0                         | Excellent               | 0.7                                      |   |
| 1 oz. (35 µm) Rolled           | 55<br>(1.4)           | 12<br>(0.3)                | 22.0<br>(152)               | 13.0                        | Excellent               | 1.4                                      |   |
| 2 oz. (70 µm) Rolled           | 55<br>(1.4)           | 12<br>(0.3)                | 28.0<br>(193)               | 27.0                        | Excellent               | 2.8                                      |   |
| Plates                         | Alloy                 | Surface Roughness min (mm) | Machinability               | Tensile Strength kpsi (MPa) | Density                 | Thermal Conductivity W/m <sup>2</sup> /K | Coefficient of Thermal Expansion ppm/°C |
| Aluminum                       | 6061                  | 70<br>(1.8)                | Poor                        | 20<br>(138)                 | 2.7                     | 150                                      | 24                                      |
| Brass                          | 70/30 Cartridge       | 70<br>(1.8)                | Good                        | 45<br>(311)                 | 8.5                     | 120                                      | 20                                      |
| Copper                         | 110                   | 70<br>(1.8)                | Fair to Good                | 35<br>(242)                 | 8.9                     | 390                                      | 17                                      |

### NOTES:

\*estimated

- 1) Measured by IPC-TM-650 method 2.5.5.5 at ~10 GHz, 23°C. RT/duroid 6010 materials were based on testing a 0.025" thick sheet clad with 1 oz. electrodeposited copper.  $\epsilon_r$  values and tolerances reported by IPC-TM-650 method 2.5.5.5 are the basis for quality acceptance, but for some products these values may be incorrect for design engineering applications, especially those in microstrip. We recommend that prototype boards of a new design be verified for electrical performance.
- 2) Measured by IPC-TM-650 method 2.5.5.5 at ~10 GHz modified.
- 3) Young's modulus (elastic modulus), steepest region of the stress/strain curve is in tension for X and Y axes by ASTM D 638; in compression for Z axis by ASTM D 695 on 12.7 x 12.7 x 25.4 mm stacked specimen.
- 4) Testing conditions: 24 hours @ 23°C, specimens etched free of copper.
- 5) Tested by ASTM C 518.
- 6) Tested by ASTM D3386-94. Values are average over temperature range but not necessarily linear. However, for RT/duroid 6002 and TMM grades the response is essentially linear.
- 7) The nominal dielectric constant of an 0.060 thick RO3003/RO3203 laminate as measured by the IPC-TM-650, 2.5.5.5 will be 3.04 due to the elimination of biasing caused by air gaps in the test fixture. For further information refer to Rogers T.R. 5242.
- 8) See the RO4000 series material data sheet for 0.004" material.

Typical values are a representation of an average value for the population of that property. For specification values contact Rogers Corporation.

# Ordering Information

Rogers High Frequency Laminates can be purchased by contacting your Customer Service Representative at (480) 961-1382 or one of our international offices listed below.

To ensure you receive the right material for your application, please include order information for each of the categories listed below. For more detailed product information, refer to the charts in the product selector guide.

## GRADE:

**Laminates** - RT/duroid® 5870, 5880, 6002, 6006, 6010LM, ULTRALAM® 2000, TMM® 3,4,6,10, and 10i, RO3003®, RO3203®, RO3006®, RO3010®, RO3210®, RO4003®, and RO4350B® high frequency laminates.

**Bonding Film** - 3001 **Prepreg** - RO4450B®

## THICKNESS AND TOLERANCE:

Laminate thickness is normally specified as the dielectric thickness without copper cladding. Refer to the data sheets for standard thicknesses and tolerances. Custom tolerances available on RT/duroid laminates and TMM laminates upon request.

## TYPE OF FOIL CLADDING:

¼, ½, 1, 2 oz. electrodeposited copper foil, ½, 1, 2 oz. rolled copper foil. RO3000 series and RO4000 series laminates are not supplied with ¼ oz. electrodeposited or rolled copper foil. TMM laminates are supplied with electrodeposited (ED) foil only.

Some material grades may be supplied unclad. Call our Customer Service Representatives for unclad options.

Thick metal cladding is available on our RT/duroid laminates only. Thick aluminum, copper, and brass claddings are also available in a range of thicknesses and thickness tolerances. Other thick metal backings are available upon request.

## STANDARD PANEL SIZES:

|  |  |
|--|--|
| RT/duroid 6006/6010LM laminates:   | 10" X 10" (254mm X 254mm), 10"X20" (254mm X 508mm)   |
| ULTRALAM 2000, RT/duroid 5870, 5880, 6002<br>RO3203, RO3210, 3006, 3010 laminates: | 18" X 12" (457mm X 305mm), 18" X 24" (457mm X 610mm),<br>18" X 36" (457mm X 914mm), 18" X 48" (457mm X 1.219m) |
| TMM 3,4,6,10,10i laminates:  | 18" X 12" (457mm X 305mm) , 18" X 24" (457mm X 610mm)  |
| RO3003 laminate and RO4000 series laminates:                                       | 12" X 18" (305mm X 457mm) , 24" X 18" (610mm X 457mm)  |
| RO4450B Prepreg:   | 24" X 18" (610mm X 457mm)  |

## SPECIFICATION REQUIREMENTS:

Standard specifications are Rogers material specifications. Certificates of conformance are available.

All other requirements must be identified at the time the order is placed. If special testing or data generation is required, additional costs may be incurred.

## CONTACT INFORMATION:

|            |   |                     |                     |
|------------|---|---------------------|---------------------|
| USA:       | Rogers Advanced Circuit Materials, ISO 9002 Certified | Tel: 480-961-1382   | Fax: 480-961-4533   |
| Belgium:   | Rogers N.V.   | Tel: +32-9-2353611  | Fax: +32-9-2353658  |
| Japan:     | Rogers Japan Inc.                                     | Tel: 81-33-807-6430 | Fax: 81-33-807-6319 |
| Taiwan:    | Rogers Taiwan Inc.                                    | Tel: 886-2-86609056 | Fax: 886-2-86609057 |
| Korea:     | Rogers Korea Inc.                                     | Tel: 82-31-716-6112 | Fax: 82-31-716-6208 |
| Singapore: | Rogers Technologies Singapore Inc.                    | Tel: 65-747-3521    | Fax: 65-747-7425    |

The information contained in this datasheet is intended to assist you in designing with Rogers laminates. They are not intended to and do not create any warranties, express or implied, including any warranty of merchantability or fitness for a particular application. The user should determine the suitability of Rogers laminates for each application.

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