

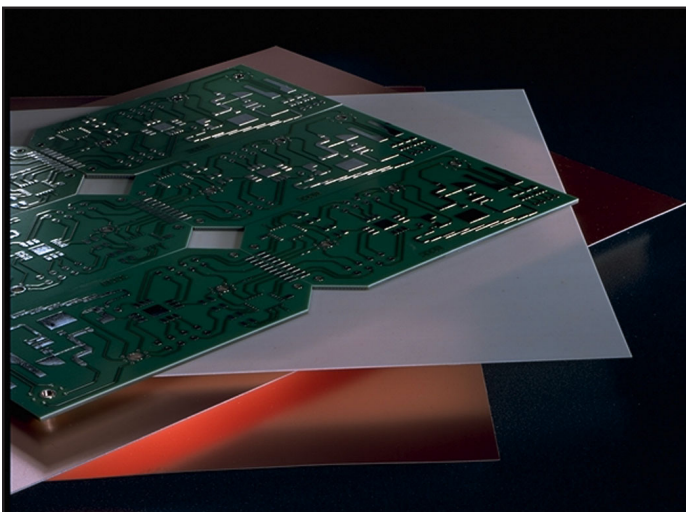
## RO4000® Series High Frequency Circuit Materials

### Features:

- Not-PTFE
- Excellent high frequency performance due to low dielectric tolerance and loss
- Stable electrical properties versus frequency
- Low thermal coefficient of dielectric constant
- Low Z-Axis expansion
- Low in-plane expansion coefficient
- Excellent dimensional stability
- Volume manufacturing process

### Some Typical Applications:

- LNB's for Direct Broadcast Satellites
- Microstrip and Cellular Base Station Antennas and Power Amplifiers
- Spread Spectrum Communications Systems
- RF Identifications Tags
- Automated Test Equipment
- High Speed Backplanes and Line Cards
- High Frequency Automotive Electronics



RO4000® Series High Frequency Circuit Materials are glass reinforced hydrocarbon/ceramic laminates (**Not-PTFE**) designed for performance sensitive, high volume commercial applications.

RO4000 laminates are designed to offer superior high frequency performance and low cost circuit fabrication. The result is a low loss material which can be fabricated using standard epoxy/glass (FR4) processes offered at competitive prices.

The selection of laminates typically available to designers is significantly reduced once operational frequencies increase to 500 MHz and above. RO4000 material possesses the properties needed by designers of RF microwave circuits. Stable electrical properties over environmental conditions allow for repeatable design of filters, matching networks and controlled impedance transmission lines. Low dielectric loss allows RO4000 series material to be used in many applications where higher operating frequencies limit the use of conventional circuit board laminates. The temperature coefficient of dielectric constant is among the lowest of any circuit board material (Chart 1), making it ideal for temperature sensitive applications. RO4000 materials exhibit a stable dielectric constant over a broad frequency range (Chart 2). This makes it an ideal substrate for broadband applications.

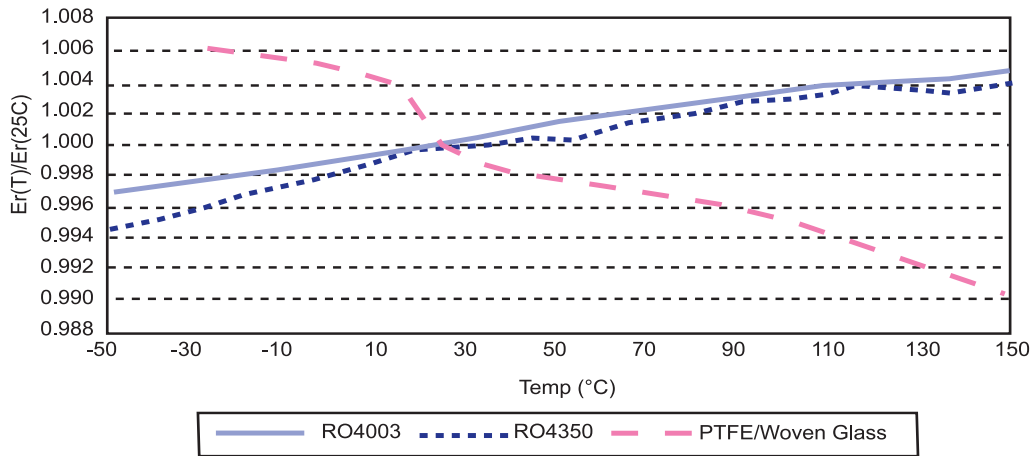
RO4000 material's thermal coefficient of expansion (CTE) provides several key benefits to the circuit designer. The expansion coefficient of RO4000 material is similar to that of copper which allows the material to exhibit excellent dimensional stability, a property needed for mixed dielectric multilayer board constructions. The low Z-axis CTE of RO4000 laminates provides reliable plated through-hole quality, even in severe thermal shock applications. RO4000 series material has a Tg of >280°C (536°F) so its expansion characteristics remain stable over the entire range of circuit processing temperatures.

RO4000 series laminates can easily be fabricated into printed circuit boards using standard FR4 circuit board processing techniques. Unlike PTFE based high performance materials, RO4000 series

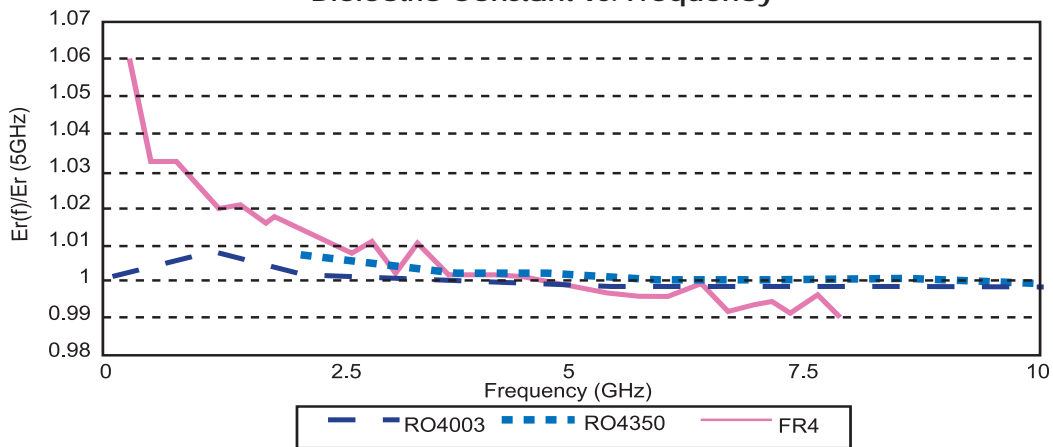
laminates do not require specialized via preparation processes such as sodium etch. This material is a rigid, thermoset laminate that is capable of being processed by automated handling systems and scrubbing equipment used for copper surface preparation.

RO4000 laminates are currently offered in various configurations utilizing both 1080 and 1674 glass fabric styles, with all configurations meeting the same laminate electrical performance specification. Responding to the need for higher Relative Thermal Index (RTI) values than 105°C, we have developed the RO4350B™ laminate, which exhibits RTI values as high as 150°C. Specifically designed as a drop-in replacement for RO4350™ material, RO4350B laminate is the standard flame retardent product in the RO4000 product line. These materials conform to the requirements of IPC-4103, slash sheet /10 for RO4003C and /11 for RO4350B.

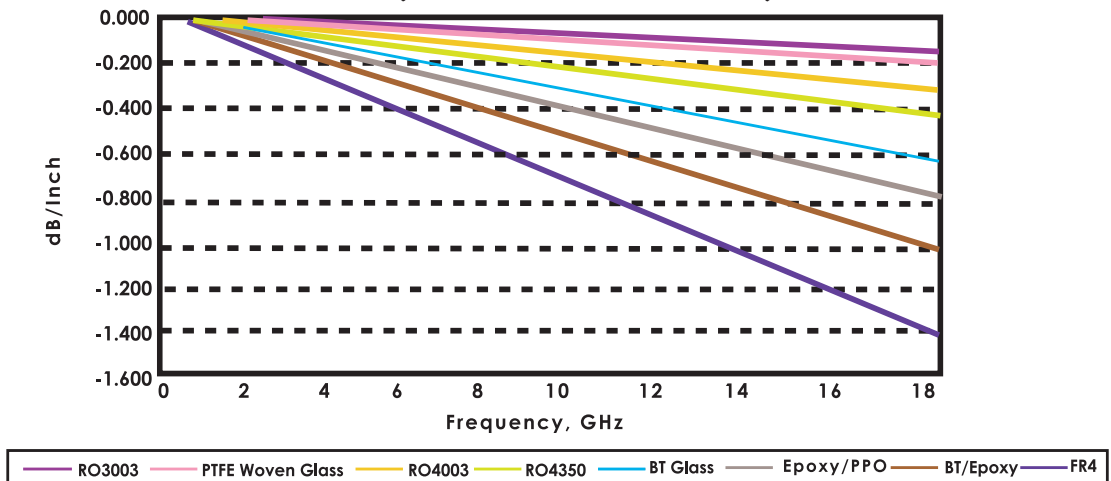
**Chart 1: RO4000 Series Materials  
Dielectric Constant vs. Temperature**



**Chart 2: RO4000 Series Materials  
Dielectric Constant vs. Frequency**



**Chart 3: Microstrip Insertion Loss  
(0.030" Dielectric Thickness)**



**TYPICAL VALUES**

**RO4003C™, RO4350B™ High Frequency Laminates**

PROPERTY	TYPICAL VALUE		DIRECTION	UNITS	CONDITION	TEST METHOD
	RO4003C	RO4350B <sup>(1)</sup>				
Dielectric Constant, $\epsilon_r$	3.38±0.05	3.48±0.05 <sup>(2)</sup>	Z	--	10 GHz/23°C 2.5 GHz/23°C	IPC-TM-650 2.5.5.5
Dissipation Factor tan, $\delta$	0.0027 0.0021	0.0037 0.0031	Z	--	10 GHz/23°C 2.5 GHz/23°C	IPC-TM-650 2.5.5.5
Thermal Coefficient of $\epsilon_r$	+40	+50	Z	ppm/ °C	-100°C to 250°C	IPC-TM-650 2.5.5.5
Volume Resistivity	1.7 X 10 <sup>10</sup>	1.2 X 10 <sup>10</sup>		MΩ•cm	COND A	IPC-TM-650 2.5.17.1
Surface Resistivity	4.2 X 10 <sup>9</sup>	5.7 X 10 <sup>9</sup>		MΩ	COND A	IPC-TM-650 2.5.17.1
Electrical Strength	31.2 (780)	31.2 (780)	Z	KV/mm (V/mil)	0.51mm (0.020")	IPC-TM-650 2.5.6.2
Tensile Modulus	26,889 (3900)	11,473 (1664)	Y	MPa (kpsi)	RT	ASTM D638
Tensile Strength	141 (20.4)	175 (25.4)	Y	MPa (kpsi)	RT	ASTM D638
Flexural Strength	276 (40)	255 (37)	-	MPa (kpsi)		IPC-TM-650 2.4.4
Dimensional Stability	<0.3	<0.5	X,Y	mm/m (mils/inch)	after etch +E2/150°	IPC-TM-650 2.4.39A
Coefficient of Thermal Expansion	11 14 46	14 16 50	X Y Z	ppm/°C	-55 to 288°C	IPC-TM-650 2.1.41
Tg	>280	>280	-	°C DSC	A	IPC-TM-650 2.4.24
Td	425	390	-	°C TGA		ASTM D 3850
Thermal Conductivity	0.64	0.62	-	W/m/°K	100°C	ASTM F433
Moisture Absorption	0.04	0.04	-	%	48 hrs immersion 0.060" sample Temperature 50°C	ASTM D570
Density	1.79	1.86	-	gm/cm <sup>3</sup>	23°C	ASTM D792
Copper Peel Strength	1.05 (6.0)	0.88 (5.0)		N/mm (pli)	after solder float 1 oz. EDC Foil	IPC-TM-650 2.4.8
Flammability	N/A	94V-O				UL
Lead-Free Process Compatible	Yes	Yes				

STANDARD THICKNESS:	STANDARD PANEL SIZE:	STANDARD COPPER CLADDING:
<b>RO4003C:</b> 0.008" (0.203mm), 0.012" (0.305mm), 0.016" (0.406mm), 0.020" (0.508mm) 0.032" (0.813mm), 0.060" (1.524mm)  <b>RO4350B:</b> 0.004" (0.101mm), 0.0066" (0.168mm) 0.010" (0.254mm), 0.0133" (0.338mm), 0.0166" (0.422mm), 0.020" (0.508mm) 0.030" (0.762mm), 0.060" (1.524mm)	12" X 18" (305 X 457 mm) 24" X 18" (610 X 457 mm) 24" X 36" (610 X 915 mm) 48" X 36" (1.224 m X 915 mm)	½ oz. (17µm), 1 oz. (35µm) and 2 oz. (70µm) electrodeposited copper foil.

(1) Dielectric constant and loss tangent are reported based on IPC-TM-2.5.5.5 @ GHz (stripline resonator). Departure from this test method or frequency may yield different values. It has been reported that in some microstrip applications, a Delta ( $\Delta$ ) of 0.2 in dielectric constant has been observed for both RO4003 and RO4350B based on actual circuit measurement and circuit modeling comparisons. It is up to the user to determine which value best fits the application and modeling software used during the design process while Rogers ensures the repeatability of the product received.

(2) Dielectric constant typical value does not apply to 0.004 (0.101mm) laminates. Dielectric constant specification value for 0.004 RO4350B material is 3.36 ± 0.05.

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