ROGERS
CORPORATION

Data Sheet

TMM® Thermoset Microwave Materials

TMM® thermoset microwave materials are ceramic, hydrocarbon, thermoset polymer composites designed for high plated-thru-hole reliability stripline and microstrip applications. TMM laminates are available in a wide range of dielectric constants and claddings.

The electrical and mechanical properties of TMM laminates combine many of the benefits of both ceramic and traditional PTFE microwave circuit laminates, without requiring the specialized production techniques common to these materials. TMM laminates do not require a sodium napthanate treatment prior to electroless plating.

TMM laminates have an exceptionally low thermal coefficient of dielectric constant, typically less than 30 ppm/°C. The material's isotropic coefficients of thermal expansion, very closely matched to copper, allow for production of high reliability plated through holes, and low etch shrinkage values. Furthermore, the thermal conductivity of TMM laminates is approximately twice that of traditional PTFE/ceramic laminates, facilitating heat removal.

TMM laminates are based on thermoset resins, and do not soften when heated. As a result, wire bonding of component leads to circuit traces can be performed without concerns of pad lifting or substrate deformation.

TMM laminates combine many of the desirable features of ceramic substrates with the ease of soft substrate processing techniques. TMM laminates are available clad with 1/2 oz/ft^2 to 2 oz/ ft^2 electrodeposited copper foil, or bonded directly to brass or aluminum plates. Substrate thicknesses of 0.015" to 0.500" are available. The base substrate is resistant to etchants and solvents used in printed circuit production. Consequently, all common PWB processes can be used to produce TMM thermoset microwave materials.

Features and benefits:

Wide range of dielectric constants
- Ideal for single material systems on a wide variety of applications

Exceptional mechanical properties
- Resist creep and cold flow

Coefficient of thermal expansion matched to copper
- High reliability of plated through holes

Resistant to process chemicals
- Reduces damage to material during fabrication and assembly processes

Thermoset resin
- Reliable wirebonding
- No specialized production techniques required
- TMM10 and 10i laminates can replace alumina substrates

Some Typical Applications:

- RF and microwave circuitry
- Power amplifiers and combiners
- Filters and coupler
- Satellite communication systems
- Global Positioning Systems Antennas
- Patch Antennas
- Dielectric polarizers and lenses
- Chip testers

Advanced Connectivity Solutions
100 S. Roosevelt Avenue, Chandler, AZ 85226
Tel: 480-961-1382 Fax: 480-961-4533 www.rogerscorp.com

ELECTRICAL PROPERTIES[1]	TYPICAL VALUES[2] TMM3	TMM4	TMM6	TMM10	TMM10i	TMM13i	DIRECTION	UNITS	CONDITIONS	TEST METHOD
[1] Dielectric Constant (process)	3.27 ± 0.032	4.50 ± 0.045	6.00 ± 0.080	9.20 ± 0.230	9.80 ± 0.245	[3]12.85 ± 0.35	Z	-	10 GHz	IPC-TM-650 method 2.5.5.5
[2] Dielectric Constant (design)	3.45	4.70	6.3	9.8	9.9	12.2	-	-	8 GHz - 40 GHz	Differential Phase Length Method
[1] Dissipation Factor (process)	0.0020	0.0020	0.0023	0.0022	0.0020	0.0019	Z	-	10 GHz	IPC-TM-650 method 2.5.5.5
Thermal Coefficient of Dielectric Constant	+37	+15	-11	-38	-43*	-70	-	ppm/°K	-55 to +125°C	IPC-TM-650 method 2.5.5.5
Insulation Resistance	>2000	>2000	>2000	>2000	>2000	>2000	-	Gohm	C/96/60/95	ASTM D257
Volume Resistivity	3X10^{9}	6X10^{8}	1X10^{8}	2X10^{8}	2X10^{8}	-	-	Mohm cm	-	ASTM D257
Surface Resistivity	>9X10^{9}	1X10^{9}	1X10^{9}	4X10^{7}	4X10^{7}	-	-	Mohm	-	ASTM D257
Electrical Strength (dielectric strength)	441	371	362	285	267	213	Z	V/mil	-	IPC-TM-650 method 2.5.6.2
Thermal Properties[1]										
Decomposition Temperature (Td)	425	425	425	425	425	425	425	°C TGA	-	ASTM D3850
Coefficient of Thermal Expansion - x	15	16	18	21	19	19	X	ppm/K	0 to 140°C	ASTM E 831 IPC-TM-650, 2.4.41
Coefficient of Thermal Expansion - y	15	16	18	21	19	19	Y	ppm/K	0 to 140°C	ASTM E 831 IPC-TM-650, 2.4.41
Coefficient of Thermal Expansion - z	23	21	26	20	20	20	Z	ppm/K	0 to 140°C	ASTM E 831 IPC-TM-650, 2.4.41
Thermal Conductivity	0.70	0.70	0.72	0.76	0.76	-	Z	W/m/K	80°C	ASTM C518
Mechanical Properties[1]										
Copper Peel Strength after Thermal Stress	5.7 (1.0)	5.7 (1.0)	5.7 (1.0)	5.0 (0.9)	5.0 (0.9)	4.0 (0.7)	X,Y	lb/inch (N/mm)	after solder float 1 oz. EDC	IPC-TM-650 Method 2.4.8
Flexural Strength (MD/CMD)	16.53	15.91	15.02	13.62	-	-	X,Y	kpsi	A	ASTM D790
Flexural Modulus (MD/CMD)	1.72	1.76	1.75	1.79	1.80*	-	X,Y	Mpsi	A	ASTM D790
Physical Properties[1]										
Moisture Absorption (2X2) 1.27mm (0.050″)	0.06	0.07	0.06	0.09	0.16	0.16	-	%	D/24/23	ASTM D570
Moisture Absorption (2X2) 3.18mm (0.125″)	0.12	0.18	0.20	0.20	0.13	0.13				
Specific Gravity	1.78	2.07	2.37	2.77	2.77	3.0	-	-	A	ASTM D792
Specific Heat Capacity	0.87	0.83	0.78	0.74	0.72*	-	-	J/g/K	A	Calculated
Lead-Free Process Compatible	YES	YES	YES	YES	YES	YES	-	-	-	-

Notes: ASTM E831 corresponds to IPC-TM-650, method 2.4.41 * estimated

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

(1) Prolonged exposure in an oxidative environment may cause changes to the dielectric properties of hydrocarbon based materials. The rate of change increases at higher temperatures and is highly dependent on the circuit design. Although Rogers' high frequency materials have been used successfully in innumerable applications and reports of oxidation resulting in performance problems are extremely rare, Rogers recommends that the customer evaluate each material and design combination to determine fitness for use over the entire life of the end product.

(2) The design Dk is an average number from several different tested lots of material and on the most common thickness/s. If more detailed information is required, please contact Rogers Corporation. Refer to Rogers Technical paper "Dielectric Properties of High Frequency Materials" available on www.rogerscorp.com/acs.

(3) Method 2.5.5.6.

Standard Thickness	Standard Panel Size	Standard Copper Cladding
0.015″ (0.381mm), 0.020″ (0.508mm), 0.025″ (0.635mm), 0.030″ (0.762mm), 0.050″ (1.270mm), 0.060″ (1.524mm), 0.075″ (1.905mm), 0.100″ (2.540mm), 0.125″ (3.175mm), 0.150″ (3.810mm), 0.200″ (5.080mm), 0.250″ (6.350mm), 0.275″ (6.985mm), 0.300″ (7.620mm), 0.500″ (12.70mm)	18″ X 12″ (457 X 305mm) 18″ X 24″ (457 X 610mm)	½ (18µm), 1 oz (35µm), 2 oz. (70µm) electrodeposited copper foil. Heavy metal cladding available. Contact Rogers customer service.

Advanced Connectivity Solutions
100 S. Roosevelt Avenue, Chandler, AZ 85226
Tel: 480-961-1382 Fax: 480-961-4533 www.rogerscorp.com