

# Recommended Base Materials by Application

Product		MultiLayer Materials									
		MCL-HS100	MCL-E-795G	GEA-775G	MCL-E-770G Type(R)	GEA-705G, GEA-770G Type(F)	MCL-E-705G	MCL-E-700G Type(R)	MCL-E-679FG	MCL-E-679F Type(R)	MCL-E-78G
Feature		High Tg, Low Dielectric Constant, Low Dissipation Factor, Low Thermal Expansion	High Tg, High Elasticity, Low Thermal Expansion	High Tg, Low Elasticity, Low Thermal Expansion	High Tg, High Elasticity, Low Thermal Expansion	High Tg, High Elasticity, Low Thermal Expansion Ultra Thin	High Tg, High Elasticity, Low Thermal Expansion	High Tg, High Elasticity, Low Thermal Expansion	High Tg, High Elasticity, Low Thermal Expansion	High Tg, High Elasticity, Low Thermal Expansion	Low Dielectric Constant, High Elasticity
Environmentally Friendly	Halogen Free	○	○	○	○	○	○	○	○	○	○
	Lead Free Application (288°C)	○	○	○	○	○	○	○	○	○	○
Consumer products	Digital Consumer Products										
	Game Instrument										
	Personal Computer										○
	Mobile Phone								○	○	
Infrastructure Products	Router-Server										
	Base Station										
	Antenna										
Electronics Devices Products	Package For Semiconductor (BGA-CSP-MCM)	○	○	○	○	○	○	○	○	○	
	Memory Modules	○	○	○	○	○	○	○	○	○	○
	Semiconductor Testing Devices	○	○	○	○	○	○	○	○	○	
	High-frequency Parts	○	○	○	○	○	○				○
Automotive Products	Electronic Control Unit	○	○	○	○	○	○	○	○	○	
	Automotive Electronics	○	○	○	○	○	○	○	○	○	
	ITS	○	○	○	○	○	○	○	○	○	
UL ANSI		—	—	—	—	—	—	—	FR-4.1	FR-4.0	FR-4.1
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Product		MultiLayer Materials			Materials For ICT Infrastructure			Polyimide Multilayer Materials	Glass Epoxy Double Side Materials	CEM-3	Materials for Fine Patterning
		TD-002	MCL-E-75G	MCL-E-67	MCL-E-679 Type(W)	MCL-LW-900G MCL-LW-910G	MCL-HE-679G Type (S)	MCL-I-671	MCL-E-67	E-668T Type(K)	PF-EL
Feature		Low Elastic Modulus	High Tg, High Heat Resistance	Good Dimensional Reliability, and Dielectric Property	High Tg, High insulating Reliability	High Tg High Heat Resistance, Low Dielectric Constant, Low Dissipation Factor	High Heat Resistance, Low Dielectric Constant	High Tg, High Heat Resistance	Dimensional Stability, Low Warpage	High CTI CEM-3	Semi-additive Process Compatible
Environmentally Friendly	Halogen Free		⊙			⊙	⊙				⊙
	Lead Free Application (288°C)	⊙	⊙	○	⊙	⊙	⊙	⊙	⊙	○	⊙
Consumer products	Digital Consumer Products		⊙	⊙	○				⊙	⊙	
	Game Instrument		⊙	⊙	○				⊙	⊙	○
	Personal Computer		⊙	⊙	○		○			⊙	
	Mobile Phone	⊙	⊙	⊙	⊙			⊙			○
Infrastructure Products	Router·Server		⊙	○	⊙	⊙	⊙	⊙			
	Base Station		⊙		⊙	⊙	⊙				
	Antenna					⊙					
Electronics Devices Products	Package For Semiconductor (BGA·CSP·MCM)				⊙						⊙
	Memory Modules		⊙	⊙	⊙	○	⊙				○
	Semiconductor Testing Devices		○		○			⊙			○
	High-frequency Parts					○	⊙		⊙		○
Automotive Products	Electronic Control Unit	⊙	⊙	○	○				○		
	Automotive Electronics	⊙	⊙	⊙		○			○	○	○
	ITS	⊙	○	○	○	○			○		
UL ANSI		—	FR-4.1	FR-4.0	FR-4.0	—	FR-4.1	GPY	FR-4.0	CEM-3	—
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# General Characteristics

Item	Condition	Unit	Multilayer Materials										
			MCL-HS100 [Halogen Free]	MCL-E-795G [Halogen Free]	GEA-775G [Halogen Free]	MCL-E-770G Type(R) [Halogen Free]	MCL-E-705G [Halogen Free]	MCL-E-700G Type(R) [Halogen Free]	MCL-E-679FG [Halogen Free]	MCL-E-679F Type(R)	MCL-E-78G [Halogen Free]	TD-002	
			UL ANSI	—	—	—	—	—	—	FR-4.1	FR-4.0	FR-4.1	—
Tg	TMA	°C	240~260	260~290	210~240	260~280	250~270	250~270	165~175	160~170	160~170	155~170	
	DMA		240~260	300~360	250~280	300~330	295~305	295~305	200~220	190~200	200~220	—	
CTE <sup>*1</sup>	X (30~120°C)	ppm/°C	6~8	3~5	3~4	4~6	5~7	7~9	13~15	12~14	13~15	6~9	
			Y	6~8	3~5	3~4	4~6	5~7	7~9	13~15	12~14	15~17	6~9
	Z		(<Tg)	20~30	—	—	8~13	10~15	15~25	23~33	20~30	35~45	80~130
			(>Tg)	130~180	—	—	70~90	70~90	90~120	140~170	130~160	180~230	200~300
Solder Heat Resistance(260°C)	A	sec.	>300	>300	>300	>300	>300	>300	>300	>300	>300	>300	
Copper Peel Strength	18μm	A	kN/m	0.8~1.0	—	0.6~0.8	0.8~1.0	0.9~1.1	1.0~1.2	0.9~1.1	1.1~1.2	1.0~1.2	0.8~0.9
	35μm			—	—	—	—	—	—	1.1~1.2	1.2~1.3	1.1~1.3	0.9~1.1
Surface Roughness	A	μm	2~3	—	—	2~3	2~3	2~3	2~3	2~3	—	5~13	
Flexural Modulus (Lengthwise)	A	GPa	23~28	37~39	13~15	30~32	32~34	32~34	23~28	27~33	25~29	5~8	
Dielectric Constant	1MHz	C-96/20/65	—	—	—	—	4.4~4.6	4.5~4.7	4.8~5.0	5.2~5.4	4.8~5.0	4.2~4.4	—
	1GHz <sup>*2</sup>			3.9~4.1	—	3.5~3.7	4.1~4.3	4.2~4.4	4.6~4.8	4.6~4.8	4.5~4.7	3.4~3.6	3.6~3.8 <sup>*3</sup>
Dissipation Factor	1MHz	C-96/20/65	—	—	—	—	0.0030~0.0050	0.0060~0.0080	0.0080~0.0100	0.0080~0.0100	0.0080~0.0100	0.0070~0.0090	—
	1GHz <sup>*2</sup>			0.0030~0.0040	—	0.007~0.009	0.0040~0.0060	0.0070~0.0090	0.0090~0.0110	0.0160~0.0180	0.0130~0.0150	0.0090~0.0110	0.011~0.013 <sup>*3</sup>
Volume Resistivity	C-96/20/65	Ω·cm	1×10 <sup>15</sup> ~1×10 <sup>18</sup>	1×10 <sup>15</sup> ~1×10 <sup>16</sup>	1×10 <sup>14</sup> ~1×10 <sup>15</sup>	1×10 <sup>15</sup> ~1×10 <sup>16</sup>	1×10 <sup>15</sup> ~1×10 <sup>16</sup>	1×10 <sup>15</sup> ~1×10 <sup>16</sup>	1×10 <sup>15</sup> ~1×10 <sup>16</sup>	1×10 <sup>15</sup> ~1×10 <sup>16</sup>	1×10 <sup>14</sup> ~1×10 <sup>15</sup>	1×10 <sup>15</sup> ~1×10 <sup>16</sup>	
Surface Resistance	C-96/20/65	Ω	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>14</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>14</sup> ~1×10 <sup>15</sup>	
Insulation Resistance	C-96/20/65	Ω	1×10 <sup>14</sup> ~1×10 <sup>16</sup>	1×10 <sup>14</sup> ~1×10 <sup>16</sup>	1×10 <sup>14</sup> ~1×10 <sup>15</sup>	1×10 <sup>14</sup> ~1×10 <sup>16</sup>	1×10 <sup>14</sup> ~1×10 <sup>16</sup>	1×10 <sup>14</sup> ~1×10 <sup>16</sup>	1×10 <sup>14</sup> ~1×10 <sup>16</sup>	1×10 <sup>14</sup> ~1×10 <sup>16</sup>	1×10 <sup>14</sup> ~1×10 <sup>16</sup>	1×10 <sup>14</sup> ~1×10 <sup>16</sup>	
	C-96/20/65 +D-2/100		1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>14</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>14</sup> ~1×10 <sup>15</sup>	
Water Absorption	E-24/50 +D24/23	%	0.2~0.4 <sup>*5</sup>	—	0.2~0.4	0.2~0.4 <sup>*4</sup>	0.4~0.6 <sup>*4</sup>	0.4~0.6 <sup>*4</sup>	0.4~0.6 <sup>*4</sup>	0.3~0.5 <sup>*4</sup>	0.1~0.3	0.1~0.3	
Flammability (UL-94)	A	—	V-0	—	—	V-0	—	V-0	V-0	V-0	V-0	V-0	
Thermal Conductivity	Xe-flash	W/m·K	0.50~0.60	—	0.60~0.70	0.60~0.70	0.60~0.70	0.75~0.85	0.75~0.85	0.40~0.50	0.40~0.50	0.30~0.40	

\*1) Heating Rate: 10°C/min. \*2) Measured by Triplate-line Resonator \*3)Cavity Resonator \*4) 0.1mm \*5) 0.2mm

Item	Condition	Unit	Multilayer Materials		Materials For ICT Infrastructure			Polyimide Multilayer Materials	Glass Epoxy Double Sided Materials	
			MCL-E-75G Halogen Free	MCL-E-67	MCL-E-679 Type(W)	MCL-LW-900G/910G Halogen Free	MCL-HE-679G Type(S) Halogen Free	MCL-I-671	MCL-E-67	
			UL ANSI	FR-4.1	FR-4.0	FR-4.0	—	FR-4.1	GPY	FR-4.0
Tg	TMA	°C	155~170	120~130	173~183	190~210	180~190	200~213	120~130	
	DMA		195~215	150~160	205~215	240~280	260~280	230~245	—	
CTE <sup>-1</sup>	X	(30~120°C)	12~15	13~16	12~15	12~15	12~15	12~15	13~16	
	Y		14~17	14~17	14~17	12~15	14~17	12~16	14~17	
	Z	(<Tg)	30~40	50~70	50~60	35~45	30~40	50~80	50~70	
		(>Tg)	180~240	200~300	200~300	240~290	190~230	200~300	200~300	
Solder Heat Resistance(260°C)	A	sec.	>300	>120	>300	>300	>300	>300	>120	
Copper Peel Strength	18μm	A	kN/m	1.2~1.4	1.4~1.6	1.2~1.4	0.5~0.7 (HVLP)	0.5~0.7 (RT)	1.3~1.5	1.4~1.6
	35μm			1.5~1.8	1.7~2.1	1.5~1.7	0.5~0.8 (HVLP)	0.6~0.8 (RT)	1.5~1.7	1.7~2.1
Surface Roughness	A	μm	—	5~13	5~13	—	5~13	5~13	—	
Flexural Modulus (Lengthwise)	A	GPa	25~29	23~25	24~26	16~21	23~26	24~26	—	
Dielectric Constant	1MHz	C-96/20/65	—	5.0~5.2	4.7~4.8	4.7~4.8	3.30~3.80	4.10~4.30	4.2~4.4	4.7~4.8
	1GHz <sup>*2</sup>			4.4~4.6	4.1~4.2	4.2~4.3	3.20~3.70	3.70~3.90	4.1~4.3	—
Dissipation Factor	1MHz	C-96/20/65	—	0.0090~0.0110	0.0130~0.0170	0.0130~0.0150	0.0005~0.0010	0.0040~0.0060	0.0110~0.0130	0.0130~0.0170
	1GHz <sup>*2</sup>			0.0140~0.0160	0.0180~0.0200	0.0210~0.0220	0.0020~0.0035	0.0060~0.0080	0.0130~0.0150	—
Volume Resistivity	C-96/20/65	Ω·cm	1×10 <sup>15</sup> ~1×10 <sup>16</sup>	1×10 <sup>15</sup> ~1×10 <sup>16</sup>	1×10 <sup>15</sup> ~1×10 <sup>16</sup>	1×10 <sup>14</sup> ~1×10 <sup>16</sup>	1×10 <sup>14</sup> ~1×10 <sup>16</sup>	1×10 <sup>15</sup> ~1×10 <sup>16</sup>	1×10 <sup>15</sup> ~1×10 <sup>16</sup>	
Surface Resistance			Ω	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>
Insulation Resistance	C-96/20/65	Ω	1×10 <sup>14</sup> ~1×10 <sup>16</sup>	1×10 <sup>14</sup> ~1×10 <sup>16</sup>	1×10 <sup>14</sup> ~1×10 <sup>16</sup>	1×10 <sup>14</sup> ~1×10 <sup>16</sup>	1×10 <sup>14</sup> ~1×10 <sup>16</sup>	1×10 <sup>14</sup> ~1×10 <sup>16</sup>	1×10 <sup>14</sup> ~1×10 <sup>16</sup>	
	C-96/20/65 +D-2/100		1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>14</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	1×10 <sup>13</sup> ~1×10 <sup>15</sup>	
Water Absorption	E-24/50 +D24/23	%	0.08~0.12	0.12~0.14	0.15~0.20	0.2~0.4	0.1~0.3	0.10~0.20	0.06~0.08	
Flammability (UL-94)	A	—	V-0	V-0	V-0	V-0	V-0	V-0	V-0	
Thermal Conductivity	Xe-flash	W/m·K	0.60~0.70	0.30~0.40	0.30~0.40	0.40~0.50	0.40~0.50	0.25~0.35	0.30~0.40	

Above properties are typical figures as a laminate.  
The figures as PCB may change depending on its material construction.  
Above values are Hitachi experimental data and not guaranteed.

# General Characteristics

Item	Condition	Unit		CEM-3
		JIS		E-668T Type(K)
		UL ANSI		CGE3F
				CEM-3
T <sub>g</sub>	TMA	°C	130~140	
	DMA		—	
CTE	X	(30~80°C)	18~22	
	Y		19~23	
	Z	(<T <sub>g</sub> )	40~50 <sup>*1</sup>	
		(>T <sub>g</sub> )	280~300	
Solder Heat Resistance(260°C)	A	sec.	>120	
Copper Peel Strength	18μm	A	kN/m	1.2~1.6
	35μm			1.8~2.2
Surface Roughness	A	μm	—	
Flexural Modulus (Lengthwise)	A	GPa	—	
Dielectric Constant	1MHz	C-96/20/65	—	4.4~4.8
	1GHz			— <sup>*4</sup>
Dissipation Factor	1MHz	C-96/20/65	—	0.024~0.030
	1GHz			— <sup>*4</sup>
Volume Resistivity	C-96/20/65	Ω·cm	5×10 <sup>15</sup> ~5×10 <sup>16</sup>	
Surface Resistance	C-96/20/65	Ω	5×10 <sup>14</sup> ~5×10 <sup>15</sup>	
Insulation Resistance	C-96/20/65	Ω	1×10 <sup>14</sup> ~1×10 <sup>15</sup>	
	C-96/20/65 +D-2/100		1×10 <sup>13</sup> ~1×10 <sup>14</sup>	
Water Absorption	E-24/50 +D24/23	%	0.04~0.08 (1.6mm)	
Thermal Conductivity	Xe-flash	W/m·K	0.6~0.8	
Flammability (UL-94)	A	—	V-0	

\*1)30~80°C. \*2)200~250°C.