

Low Dielectric Constant Multilayer Material for Mobile “MCL-E-78G”

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1 Abstract

Amid the high functionality and high-speed communication of mobile devices such as smartphones and tablet PCs, it has become difficult to control impedance and RF characteristics by increasing wiring density and layer count. Accordingly, related motherboard designs have reached the limits for standard FR-4 material ^{1), 2)}.

We have developed a new low dielectric constant multilayer MCL-E-78G material for mobile devices. As this material shows good dielectric constant, it facilitates impedance control of PWB, meaning this material may provide an improved margin for PWB design compared to standard FR-4 material.

2 Key Features of MCL-E-78G

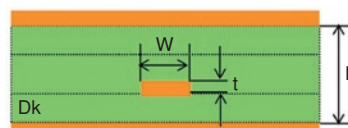
- MCL-E-78G has superior dielectric properties.
- MCL-E-78G has high thermal stability and glass transition temperature (Tg).
- MCL-E-78G is an environmentally-friendly material using halogen-free flame retardants.

3 Development Background

Recent years have seen functional improvement in mobile devices, as exemplified by smartphones. Accordingly, it is expected to become more difficult to secure a sufficient margin for PWB (printed wiring board) design due to narrowed wiring space and the increased number of layers. Lowering the dielectric constant of substrates may be one approach to solve this PWB designing problem. By lowering the dielectric constant of substrate, as indicated in Figure 1, a sufficient wiring pattern width can be secured, and an improved margin for designing PWB can be expected.

In the above context, we developed a multilayer material with lower dielectric constant than standard FR-4 material by employing resins with superior dielectric properties, which were produced based on our proprietary resin modification technology.

$$Z_0 = \frac{60}{\sqrt{Dk}} \times \ln \left(\frac{4H}{0.67\pi W \left(0.8 + \frac{t}{W} \right)} \right) \dots \dots \text{Equation to calculate impedance (Stripline)}$$



Item	Unit	Dk = 3.5	Dk = 4.3
Impedance (Zo)	Ω	50	50
Layer thickness (H)	μm	130	130
Line thickness (t)	μm	12	12
Line width (W)	μm	52	40

Figure 1 Effect of using low dielectric constant material on PWB design

4 Technical Content

1. Design concept of MCL-E-78G

MCL-E-78G adopts a resin with superior dielectric properties, which was produced based on our proprietary resin modification technology. It uses thermosetting materials with less hydroxyl group generation; hydroxyl group is the cause of dielectric properties declining, thus allowing both superior dielectric properties and high heat resistance to be attained. We also used halogen-free flame retardants with high thermal-decomposition temperature, Tg and superior dielectric properties.

2. General characteristics & properties of MCL-E-78G

Table 1 shows the general characteristics & properties of MCL-E-78G. It has dielectric constant (Dk) 3.5 and dissipation factor (Df) 0.011, which outperform the equivalent values for standard FR-4 material. Its superior heat resistance is also in evidence, having 160°C or higher Tg by the TMA method, 60 minutes or longer T-288 by (IPC TM-650), and the thermal-decomposition temperature of 380°C or higher (5% weight loss). It also achieves excellent reliability, as there was no insulation deterioration, even after 1,000 hours of the CAF resistance test (between through-hole walls: 0.3 mm, 85°C/85%RH, and applied voltage: 100 V).

Table 1 Properties of MCL-E-78G (thickness 0.8 mm)

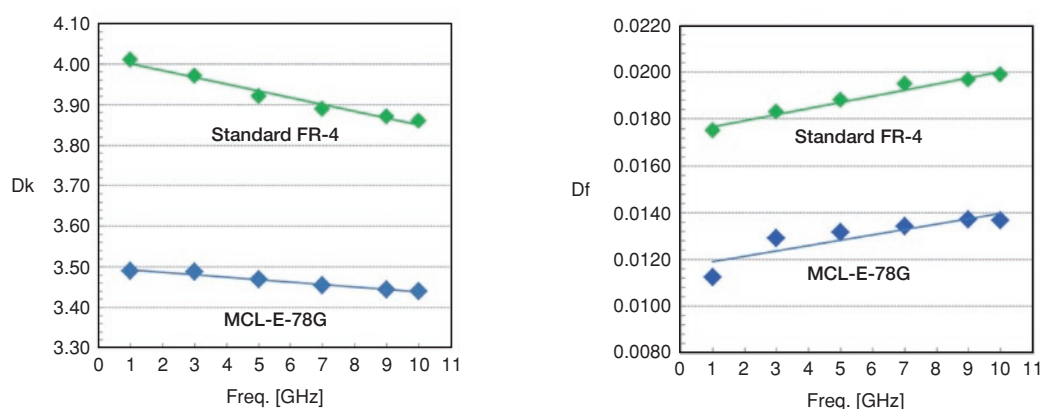
Item		Unit	MCL-E-78G	Standard FR-4
Flame Retardant		—	Halogen-free	Halogen-free
Dk (1 GHz) *1	R.C.=70%	—	3.4-3.6	3.9-4.1
Df (1 GHz) *1	R.C.=70%	—	0.009-0.012	0.016-0.019
Decomposition temp. (5 % wt loss)		°C	380-400	380-390
Tg	TMA	°C	160-170	155-170
	DMA	°C	200-220	195-215
CTE	X < Tg	ppm/°C	13-15	12-15
	Y < Tg	ppm/°C	15-17	14-17
	Z < Tg	ppm/°C	35-45	30-40
	Z > Tg	ppm/°C	180-230	180-240
Cu Peel strength	Outer layer 18 µm	kN/m	1.0-1.2	1.2-1.5
T-288 (w/Cu)	TMA	min	>60	>60
Flammability	UL-94	—	V-0	V-0
CAF properties *2	85°C/85%RH, DC100 V	hrs.	>1000	>1000

* 1) Measured by a Triplate-Line Resonator

* 2) Drill bit: Φ0.4 mm, T/H wall distance: 0.3 mm, Pre-condition: Reflow x 2 (Max 265°C)

3. Dielectric properties of the MCL-E-78G

Figure 2 shows the frequency dependence of Dk and Df up to 10 GHz. It shows MCL-E-78G has superior dielectric properties as Dk by approx. 0.5 and Df by approx. 0.006 were improved compare with standard FR-4 materials.



*) Measured by a Triplate-Line Resonator

Figure 2 Frequency dependency of relative dielectric constant and dissipation factor

5 Future Business Development

- Development of low transmission loss multilayer materials for next-generation mobile products

[References]

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- 2) Makoto Yanagita: JPCA Show2012 Proceedings of the NPI Presentation, pp. 49-51