New Low Transmission Loss & Halogen-Free Multi-Layer Material "MCL-LW-990G"

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1 Abstract

The network devices for the next generation of wireless networks, called "5G", need to use higher frequency for bigger data and higher speed communication. At higher frequency, the reduction of transmission loss on printed wiring boards (PWB) is essential to secure signal integrity. In response to such a situation, Hitachi Chemical has developed a new low transmission loss & halogen-free multi-layer material, the "MCL-LW-990G" series, which has lower transmission loss than conventional materials. "MCL-LW-990G (DZ)" can reduce transmission loss by about 21 % compared with "MCL-LW-910G", has high reliability, and is promising for the next-generation high-speed and high-frequency communication devices.

2 Characteristics of the Product

- Excellent dielectric properties (dielectric constant, dissipation factor).
- Excellent transmission properties (low transmission losses).
- Excellent heat resistance and insulation reliability.
- Halogen-free multi-layer material.

3 Background of the Development

The 5th generation mobile communication standard (5G) is in partial commercial operation. It requires higher communication speeds and increased communication capacity compared to conventional technologies. In order to realize such high-capacity and high-speed communications, it is necessary to increase the signal frequency. Technological development is progressing, including network devices such as mobile phones, base stations, and data center servers that use the frequency band from quasi-microwave to millimeter wave. For printed wiring board materials used in such network devices, there are increasing demands to suppress signal degradation due to transmission losses on the printed wiring board.

Against this background, we have developed a new low transmission loss and halogen-free multi-layer material, the "MCL-LW-990G" series, to further reduce transmission losses.

4 Technical Details

1. Development concept for "MCL-LW-990G"

Transmission losses can be broadly divided into losses due to insulation layers (dielectric loss) and losses due to circuits using copper foil, such as conductor circuits and wiring boards (conductor loss). Dielectric loss can be reduced by using a low-polarity resin, but the adhesion to the conductor, heat resistance, and flame retardance are often inadequate. Therefore, Hitachi Chemical tried to achieve both properties by adopting a polymer blend using a proprietary denaturation technology that involves a co-crosslinking reaction with a high-polarity resin that is excellent in these properties. As a result, low-roughness copper foil that is effective in reducing conductor losses can be applied to reduce both the dielectric and conductor transmission losses.

2. General properties of "MCL-LW-990G"

Table 1 shows the general properties of the developed "MCL-LW-990G". For purposes of comparison, the properties of a previous Hitachi Chemical material, "MCL-LW-910G", are also shown in this table. The new materials have a dielectric constant (Dk) of 3.0 and a dissipation factor (Df) of 0.0017 at a frequency of 10 GHz. It has superior dielectric properties to our previous

material. In addition, CTE, Tg, and solder heat resistance are equivalent or superior to “MCL-LW-910G”, and the reliability can be seen to be excellent.

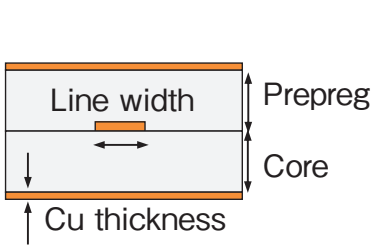
Table 1 General Properties of MCL-LW-990G

Items	Condition	Unit	LW-990G(D)	LW-990G(DZ)	LW-910G
Glass type	-	-	Low Dk glass	Lower Dk glass	Low Dk glass
Dk*	10 GHz	-	3.06	3.00	3.22
Df*	10 GHz	-	0.0020	0.0017	0.0033
CTE	TMA(Expansion)	ppm/℃	15	15	18
Tg	TMA	℃	200	200	200
Solder heat resistance	288 ℃ Float	s	> 300	> 300	> 300
Peel strength	HVLP 18 μm	kN/m	0.6	0.6	0.6

*Cavity resonator perturbation method

3. Evaluation of “MCL-LW-990G (DZ)” transmission properties

The transmission characteristics (transmission losses) in the “MCL-LW-990G (DZ)” strip-line were evaluated. **Figure 1** shows the structure and specifications of the transmission loss measurement board, and **Figure 2** shows the transmission loss evaluation results. Compared with our previous “MCL-LW-910G” material, transmission losses at 40 GHz were reduced by about 21 % and excellent transmission properties were achieved even in the millimeter wave band.



Measurement Conditions
- Method : Strip-line
- Temperature & Humidity : 25 ℃/60 %RH
- Characteristic impedance : Approx. 50 Ω
- Inner layer surface treatment : Black-reduction
- Calibration method : TRL
- Wiring length : 140 mm
- Trace thickness : 18 μm
- Core thickness : 150 μm
- Prepreg thickness : 150 μm
- Line width : 140 μm(LW-910G)
  150 μm(LW-990G(DZ))

Figure 1 Structure of Transmission Loss Measurement Board

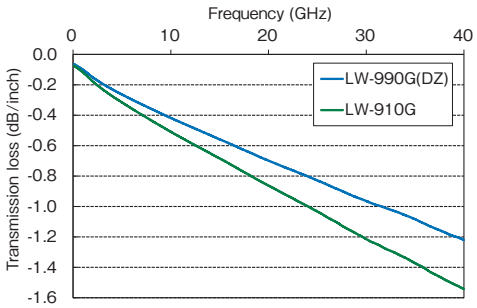
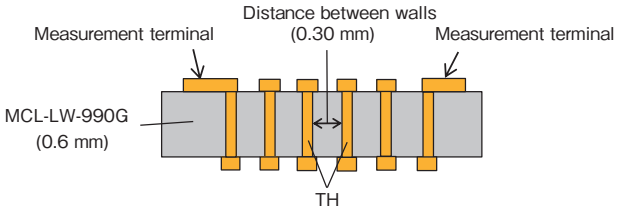


Figure 2 Transmission Loss Evaluation Results

4. Evaluation of “MCL-LW-990G” insulation reliability

Conductive anodic filaments (CAF) were evaluated between the through holes (hereinafter, “TH”). **Figure 3** shows the structure and specifications of the measurement board, and **Figure 4** shows the CAF evaluation results. The insulation properties of the “MCL-LW-990G (D)” and “MCL-LW-990G (DZ)” are good, with no drop in insulation resistance value from the beginning to 1,000 hours.



・Pre-condition : 260 ℃ reflow x 5 times
・Test condition : 85 ℃/85 %RH, DC 100 V
・Criteria : > 10^8 Ω
(Continuous measurement of insulation resistance in chamber)

Figure 3 Structure of Insulation Evaluation Board

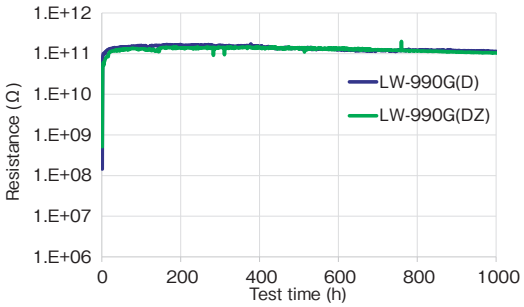


Figure 4 Insulation Evaluation Results

5 Future Business Development

・Development of new low transmission loss materials that can support the high-speed and large-capacity communications for next-generation network devices

【References】
1) Technical Information Institute Co., Ltd.: Development trends in high-frequency compatible materials and applications to 5G and millimeter-wave radar (2019)
2) Japan Marketing Survey Co., Ltd.: Trends of Millimeter Wave Radar Market (2015)