

Characteristics Evaluation Report

Halogen-free

Printed Circuit Board material **GX** series

Glass Epoxy Multi-layer material

L a m i n a t e : R - 1 5 6 6 (w)

P r e p r e g : R - 1 5 5 1 (w)

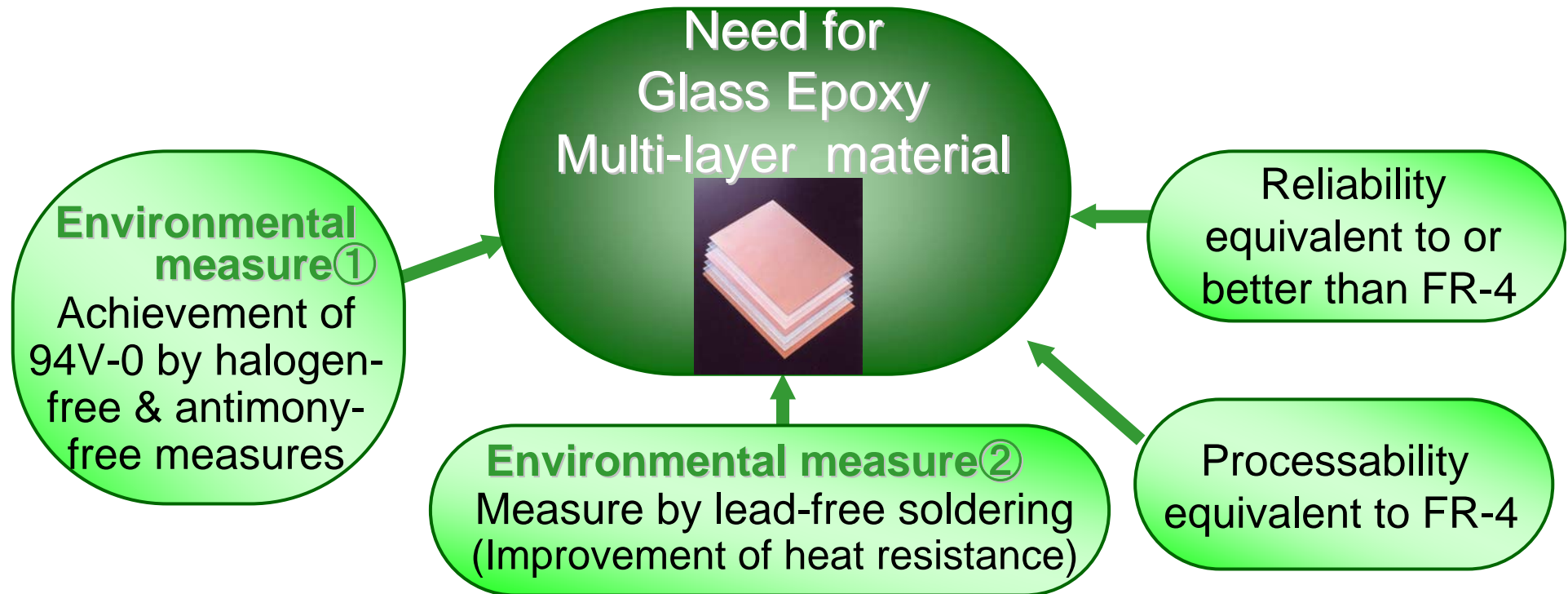
August 1, 2006

Panasonics Electric Works Electronic
Materials Taiwan Co.,Ltd

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1. Need for halogen-free material and its definition



◆ Definition of “halogen-free

By Japan Printed Circuit Association (JPCA-ES-01-1999)

	Percentage content of halogen compound	
	Definition by Japan Printed Circuit Association	Our halogen-free epoxy R-1566
Chlorine(Cl)	Not more than 0.09 wt%	0.037 wt%
Bromine (Br)	Not more than 0.09 wt%	Not yet detected

* Method of measurement: Ion chromatography

2. Features of halogen-free Glass Epoxy Multi-layer material

Achievement of UL94V-0 by halogen-free & antimony-free measures

- ① Measure by lead-free soldering
- ② Excellent heat resistance (T-288).
- ③ Excellent internal layer's peel strength.
- ④ Excellent tracking resistance. (CTI 500V)
- ⑤ Zero (0) emission of harmful gas, such as aniline, etc.
- ⑥ Punching quality is equivalent to our standard FR-4.
- ⑦ Secondary laminate's molding conditions, such as molding time, molding temperature, molding pressure, etc. are equivalent to our standard FR-4.

3-(1) solder heat resistance after water absorption

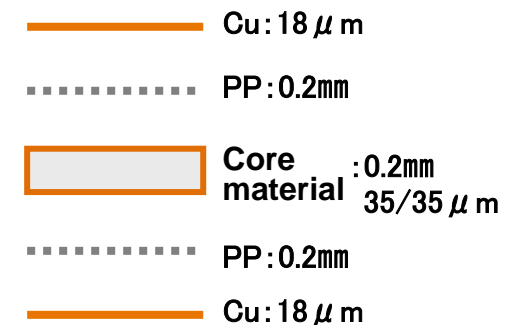
Equivalent to standard FR-4

■ Evaluation result

Condition		Halogen-free epoxy R-1566	Our standard FR-4
Thermal shock test	Floating for 10 seconds at 260°C	No blister after 10 cycles	No blister after 10 cycles
	Floating for 10 seconds at 288°C	No blister after 10 cycles	No blister after 10 cycles
Floating test	Floating at 260°C	No blister after 300 seconds	No blister after 300 seconds
	Floating at 288°C	No blister after 300 seconds	No blister after 300 seconds
Dipping test	D-X /100 + 260°C, Dipping for 30	No blister after 4 hr	No blister after 4 hr

The above data are our actual values and not assured values.

■ Evaluation sample



Internal layer's treatment : B/O

Internal layer's pattern : Grid pattern at the remaining copper ratio of 50%

3-(2) Reflow heat resistance

Equivalent to standard FR-4

■ Evaluation result

Treatment condition	Halogen-free epoxy for multi-layer (R-1566 /R-1551)	Our standard FR-4
[C-96/40/90 + reflow (280°C)] × 1	No blister	No blister
[C-96/40/90 + reflow (280°C)] × 3	No blister	No blister

The above data are our actual values and not assured values.

■ Test condition

- Reflow temperature condition: Peak temperature: 280°C (70 seconds at not less than 220°C)
- Treatment condition: C-96/40/90 + reflow
- Test sample (4-layer plate)



Size: 80 mm x 160 mm

External layer's copper foil: 18 μ m
 Prepreg: 7628 type
 Core material: 0.2mm 35/35 μ m (B/O)
 Prepreg: 7628 type
 (External layer's copper foil etching)

3-(3) Heat resistance

**Better than A-company's halogen-free material
and standard FR-4**

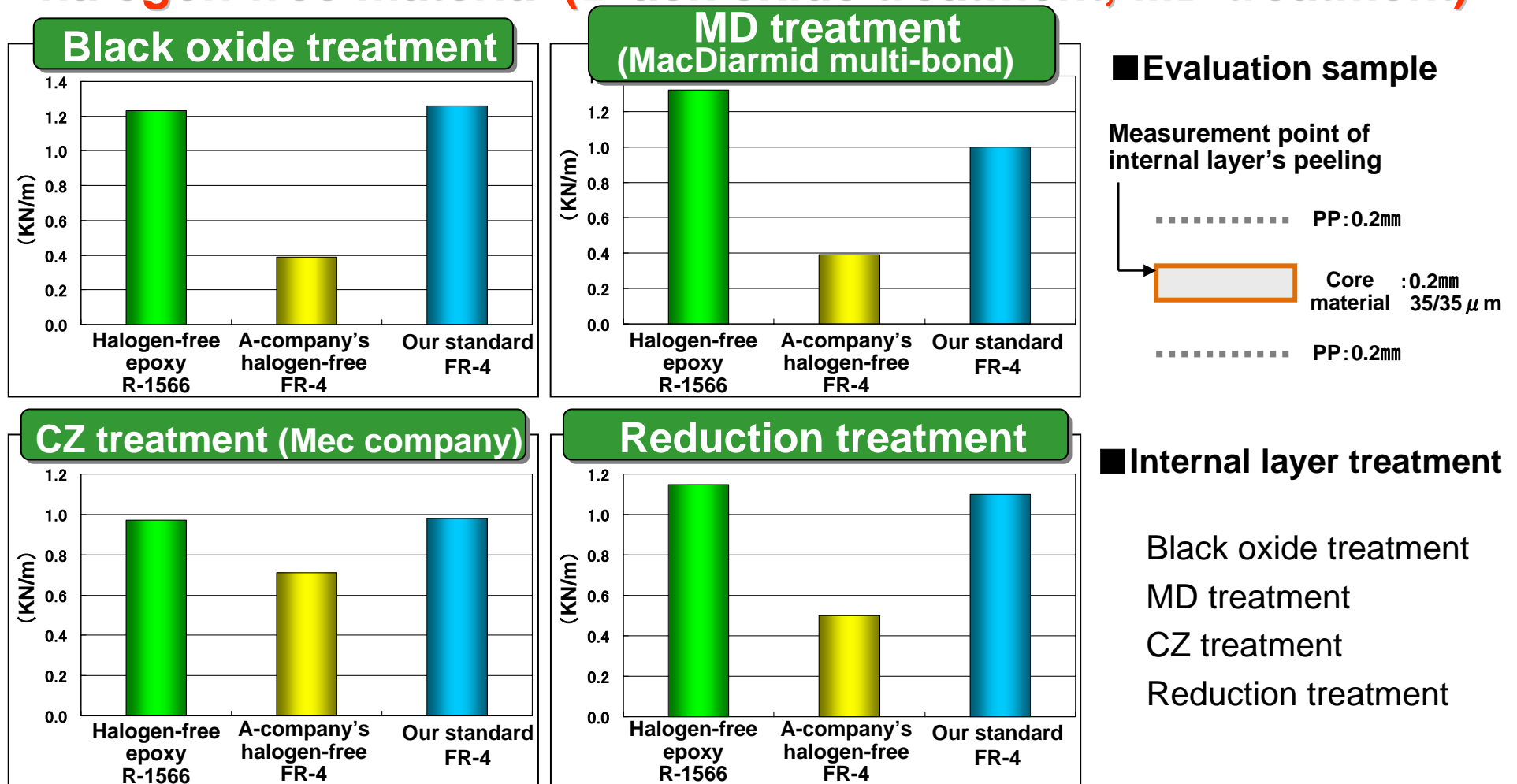
■ Evaluation sample Board thickness: 1.6 mm Copper foil: 18/18 μ m

	Halogen-free epoxy R-1566	A-company's halogen-free FR-4	Our standard FR-4
Oven heat resistance	No blister after 60 minutes at 245°C	No blister after 60 minutes at 235°C	No blister after 60 minutes at 240°C
T-260 IPC-TM-650	Not less than 120 min	14min	13min
T-288 IPC-TM-650	22min	1min	1min

The above data are our actual values and not assured values.

4-(1) Iner layer's peeling strength

Not less than 3 times as strong as A-company's halogen-free material (Black oxide treatment, MD treatment)



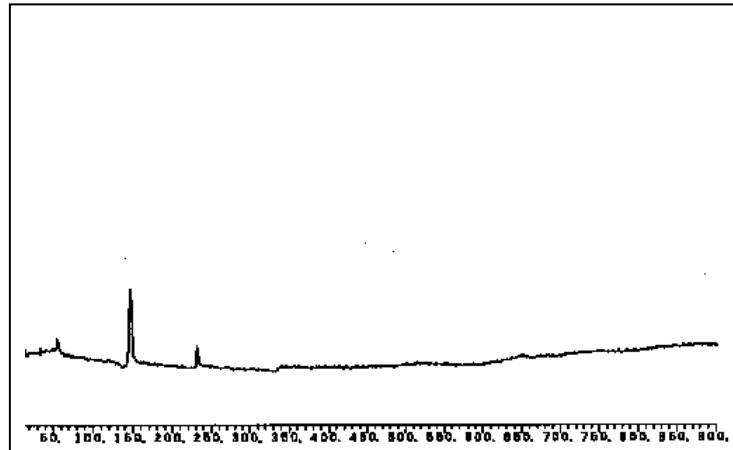
The above data are our actual values and not assured values.

4-(2) Evolved gas analysis

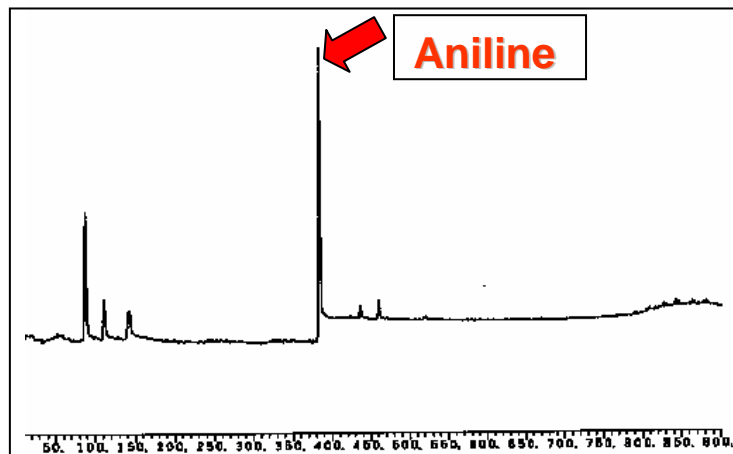
Zero (0) emission of highly poisonous aniline

■ Evaluation result (Detection graph)

Halogen-free epoxy
for multi-layer



A-company's
halogen-free material



■ Analysis method

Head space GCMS analysis
Heat up 4 g of test material in a sealed container for 120 minutes at 130°C, and analyze the amount of evolved gas by using GCMS.

What is aniline?

CAS No62-53-3

■ Classification of risk and harmful effect

Classification title: Acute poisonous substances,
other poisonous substances

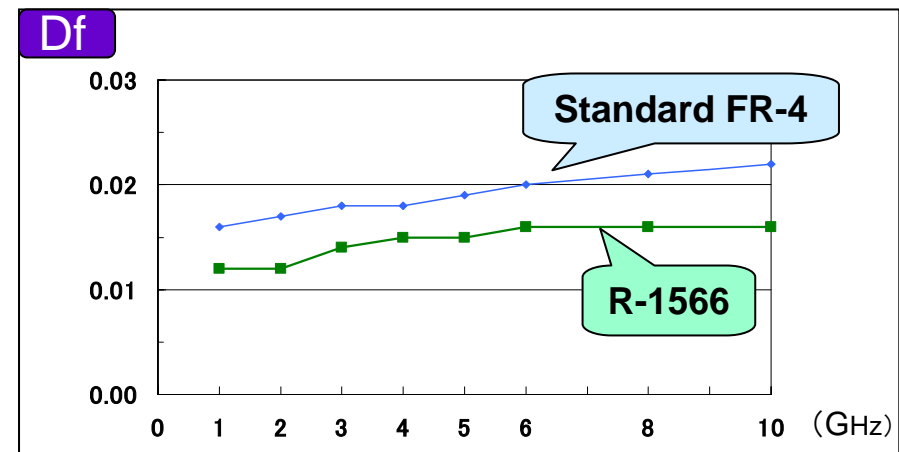
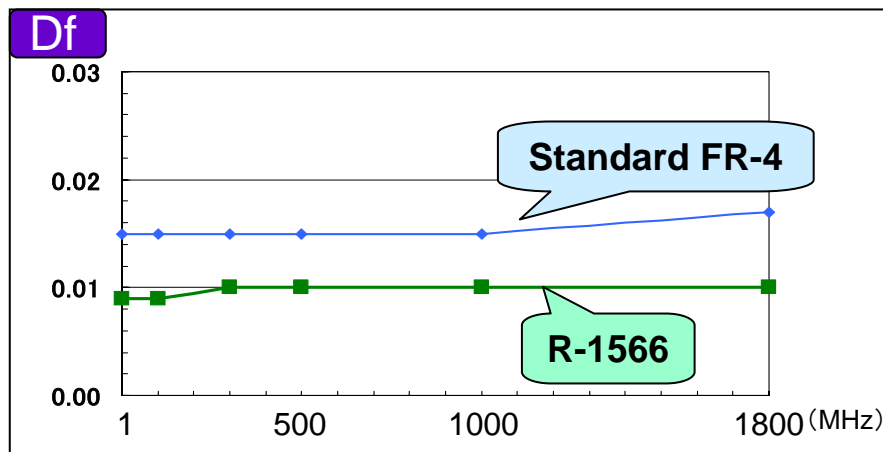
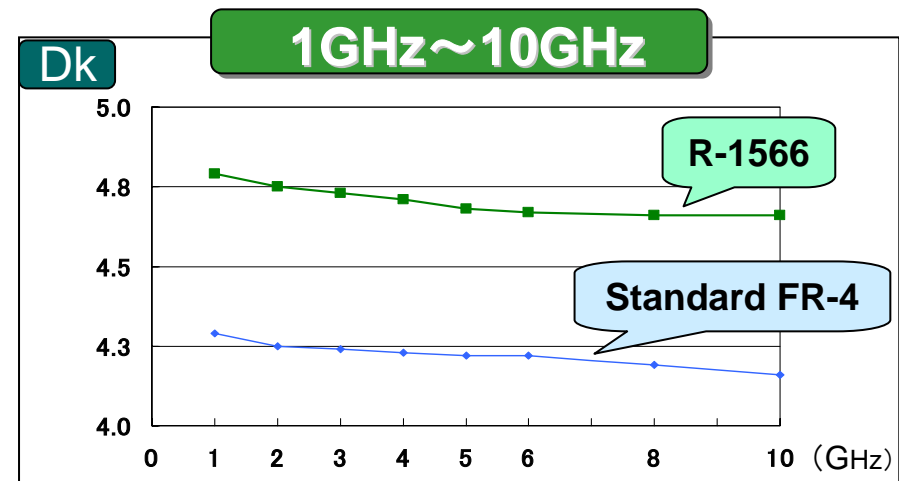
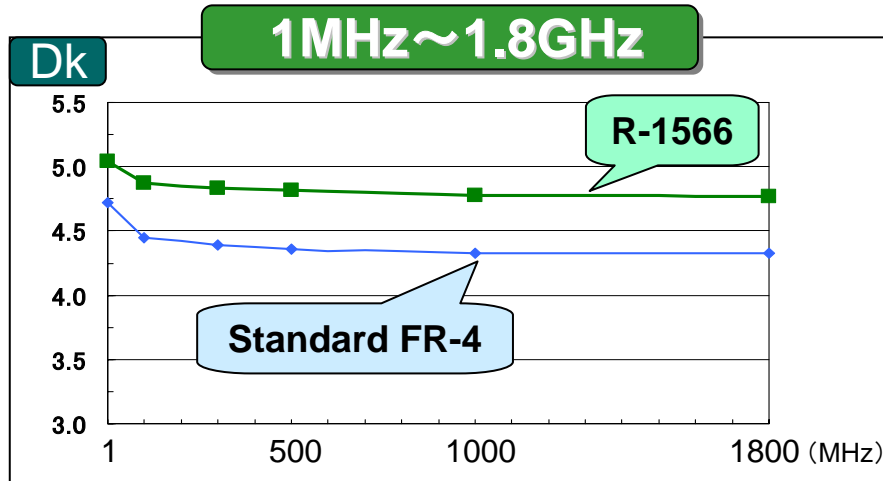
Harmful effect: Acrid to eyes. May also affect semen
and form hemoglobin. The harmful
effect may be increased by the use
of alcohol drinks.

Environmental effect: Beware of the affect on
fish and crustaceans, and
never release aniline into
the environment.

The above data are our actual values and not assured values.

5-(1) Dielectric characteristics ①

Frequency dependence (Room temperature)



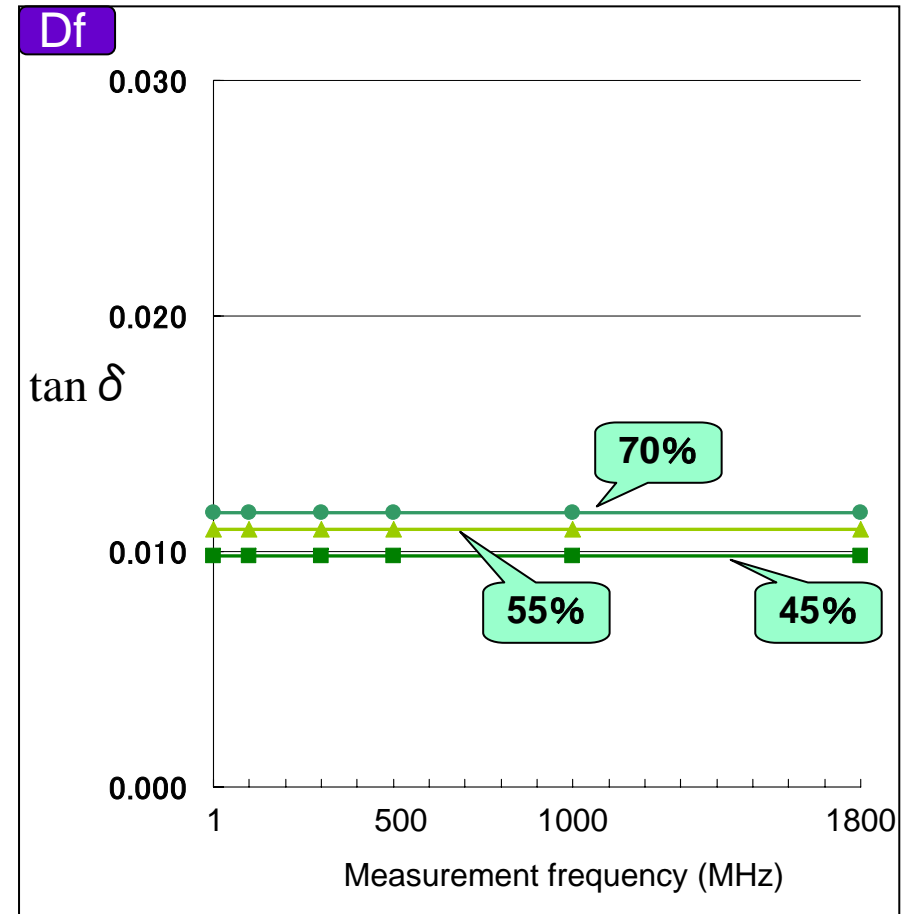
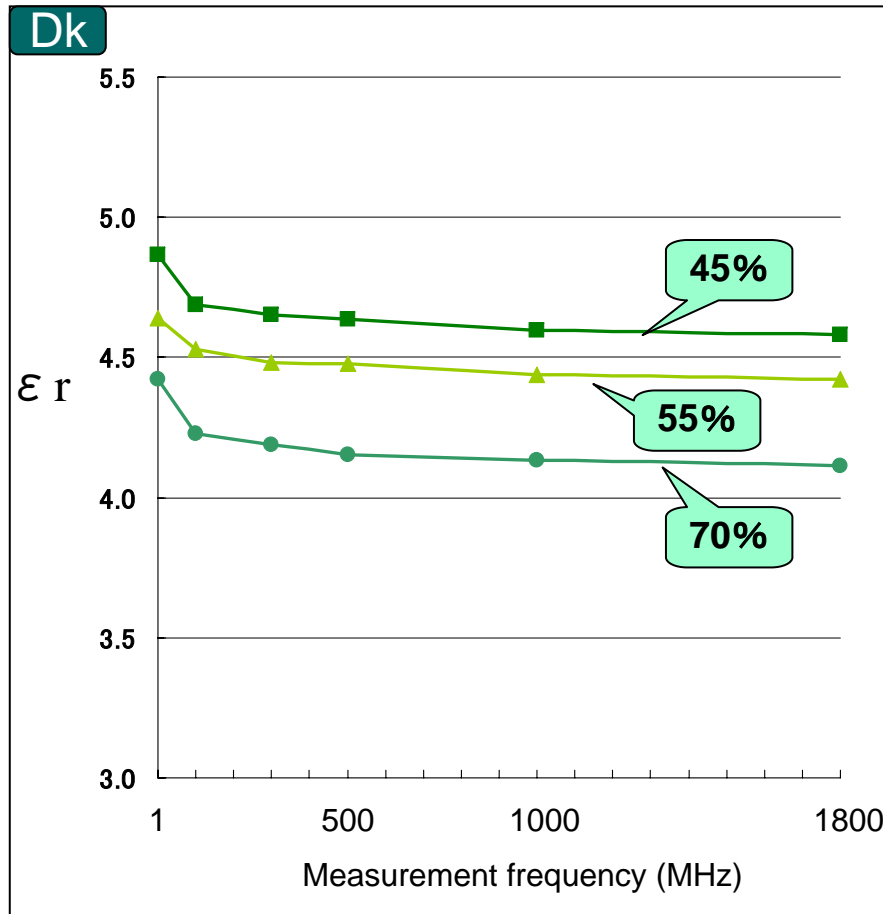
Method of measurement: Volumetric method
(Impedance/material analyzer method)
(According to IPC TM-650 2.5.5.9)

Method of measurement: Stripline resonator method
(According to IPC TM-650 2.5.5.5)

The above data are our actual values and not assured values.

5-(1) Dielectric characteristics ②

■ Dielectric characteristics by the volume of resin (Halogen-free material R1566)

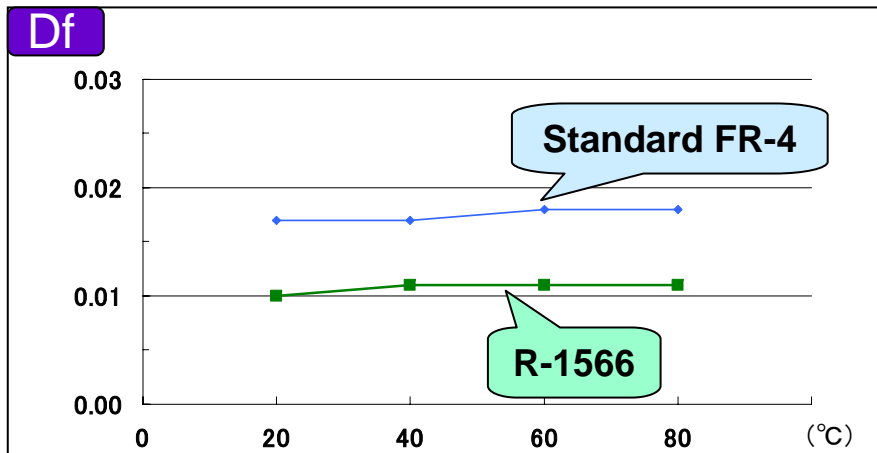
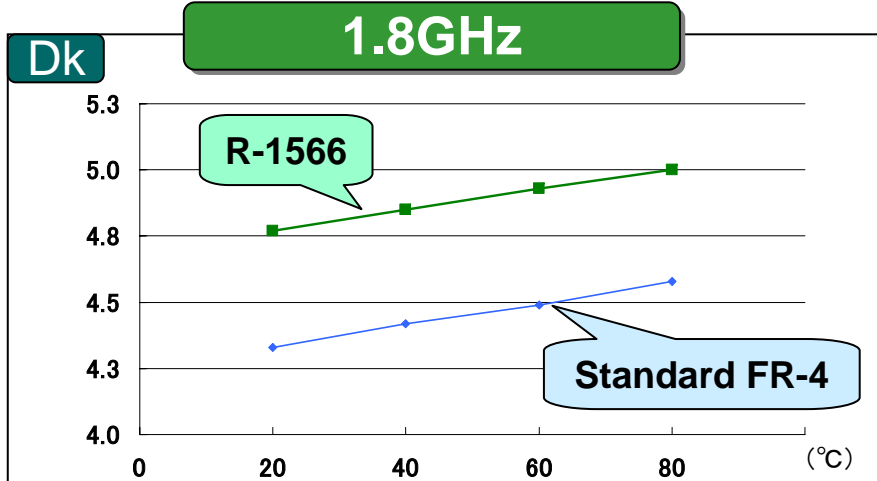


Method of measurement: Volumetric method
(Impedance/material analyzer method)
(According to IPC TM-650 2.5.5.9)

The above data are our actual values and not assured values.

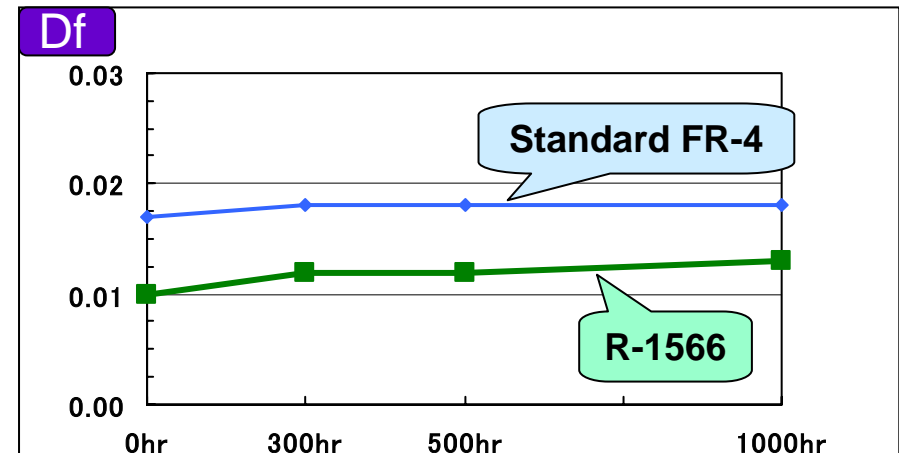
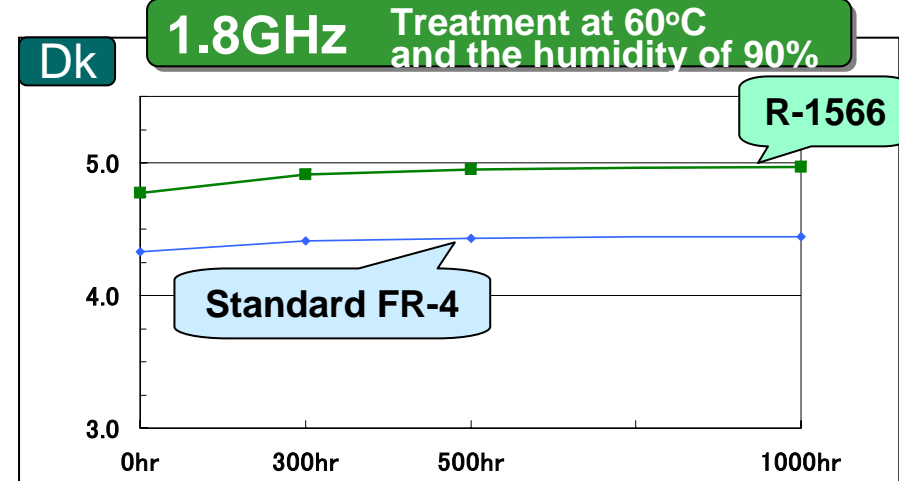
5-(1) Dielectric characteristics ③

Temperature dependence



Method of measurement: Volumetric method
(Impedance/material analyzer method)
(According to IPC TM-650 2.5.5.9)

Humidity dependence



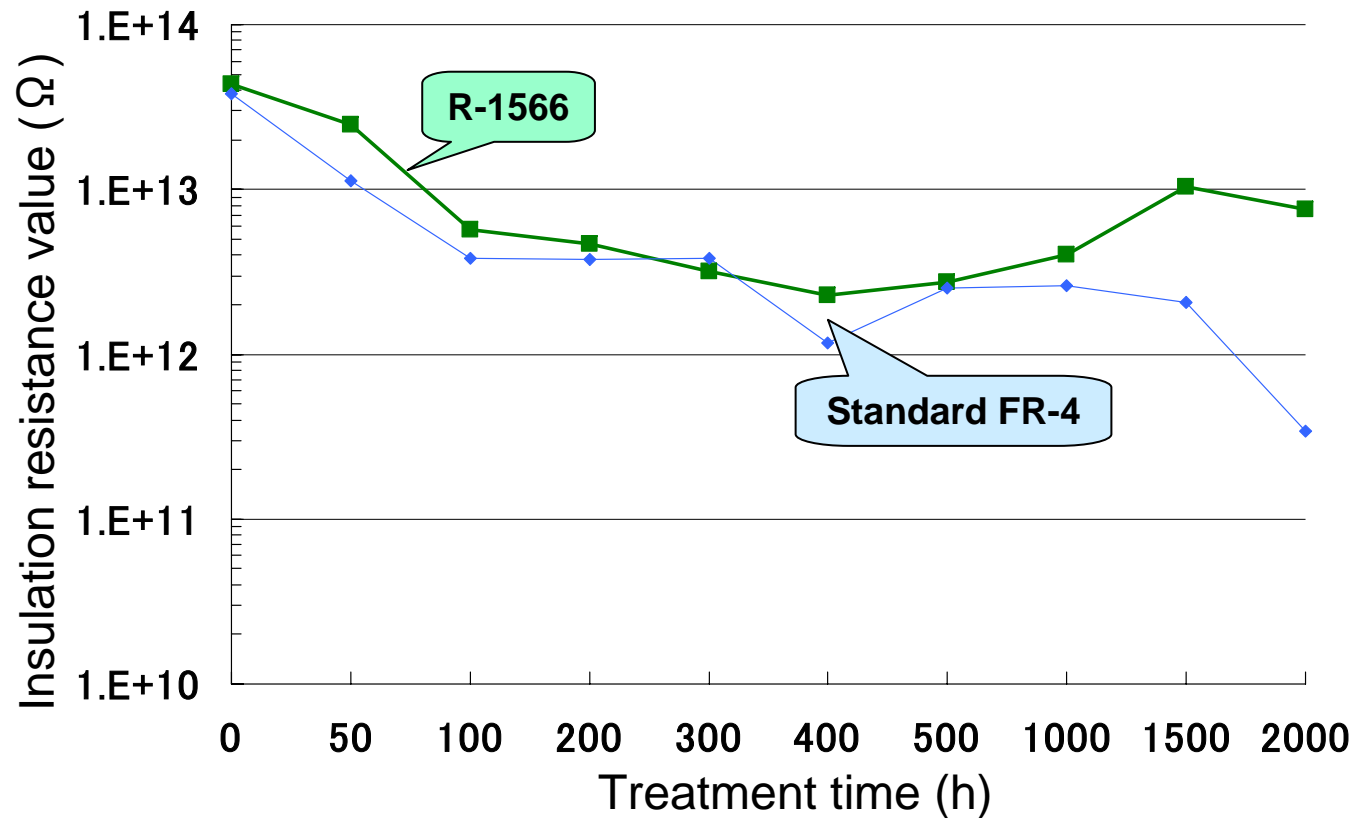
Method of measurement: Volumetric method
(Impedance/material analyzer method)
(According to IPC TM-650 2.5.5.9)

The above data are our actual values and not assured values.

5-(2) CAF resistance

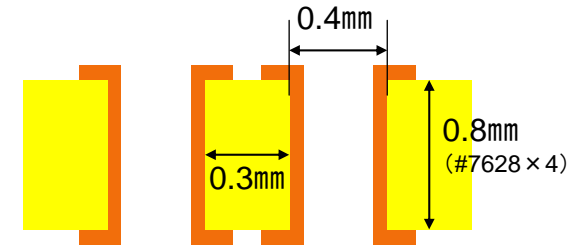
Achievement of 2000 hours with the application of 50V DC at 85°C and the relative humidity of 85%

■ Evaluation result



The above data are our actual values and not assured values.

■ Evaluation sample



Distance between hole walls : 0.3 mm
Hole diameter : 0.4 mm
Board thickness: 0.8 mm

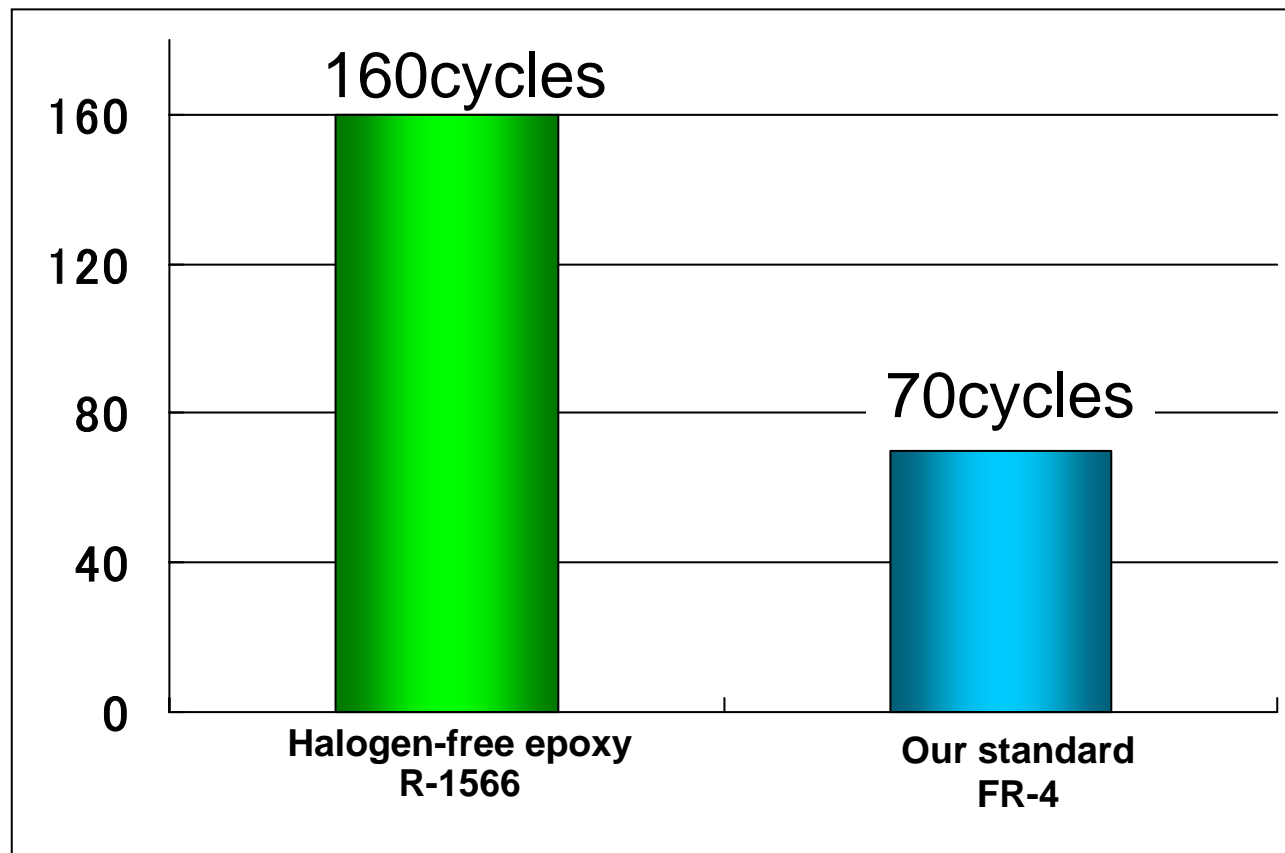
■ Treatment condition

Applies 50 V DC for 1 minute at 85°C and the relative humidity of 85%.

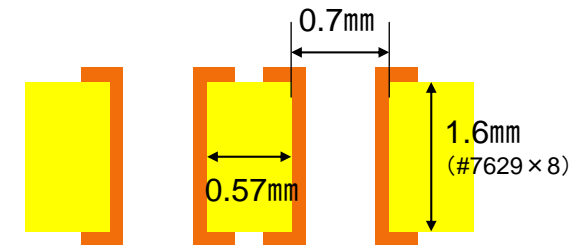
5-(3) Through hole reliability

Not less than twice as good as standard FR-4

■ Evaluation result



■ Evaluation sample



■ Treatment condition

20°C (Water) 10秒



260°C (Oil) 10秒

The above data are our actual values and not assured values.

6-(1) Drilling processability

Equivalent to standard FR-4










■ Evaluation result

Feed speed		2.2m/min [Standard]		2.6m/min		3.0m/min	
Base material to be used		R-1566	Standard FR-4	R-1566	Standard FR-4	R-1566	Standard FR-4
Accuracy of hole location	Average+3 σ	50	48	47	46	46	46
	*1 (μ m)	60	57	60	60	58	60
Hole wall roughness (45 σ bias) (μ m)	Average	11.0	11.1	10.9	12.0	10.8	11.1
	Maximum	20.0	25.0	22.5	25.0	20.0	22.5
Wear-out ratio of drill bit (%)		60	57	55	50	49	47

*1 The amount of deviation of a hole on a third substrate from the set position

The above data are our actual values and not assured values.

■ Evaluation sample


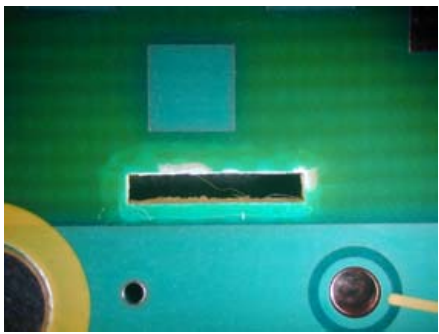

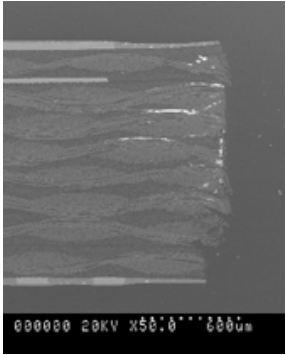
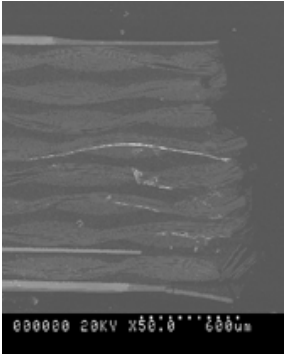
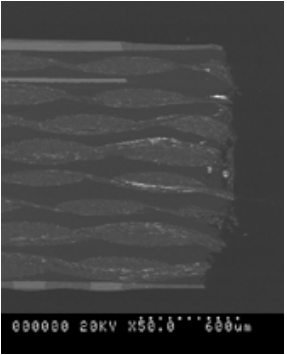
	Cu: 18 μ m
	PP: 0.1mm
	Core : 0.2mm (7628 \times 2)
	material 18/18 μ m
	PP: 0.1mm
	Core : 0.2mm (7628 \times 2)
	material 18/18 μ m
	PP: 0.1mm
	Cu: 18 μ m

■ Test condition

Drill to be used	Union tool E843 Diameter:0.25 mm, Length:4.1 mm
Number of rotation	121krpm
Number of punching	3000 holes
Stackable number of sheet	3 sheets
Feed speed	2.2m/min (18.3 μ m/rev)
	2.6m/min (21.7 μ m/rev)
	3.0m/min (25.0 μ m/rev)
Upper board	LE300
Lower board	Baking board
Step dr	Nil
Bush diameter	ϕ 3.5mm

6-(2) Punching processability

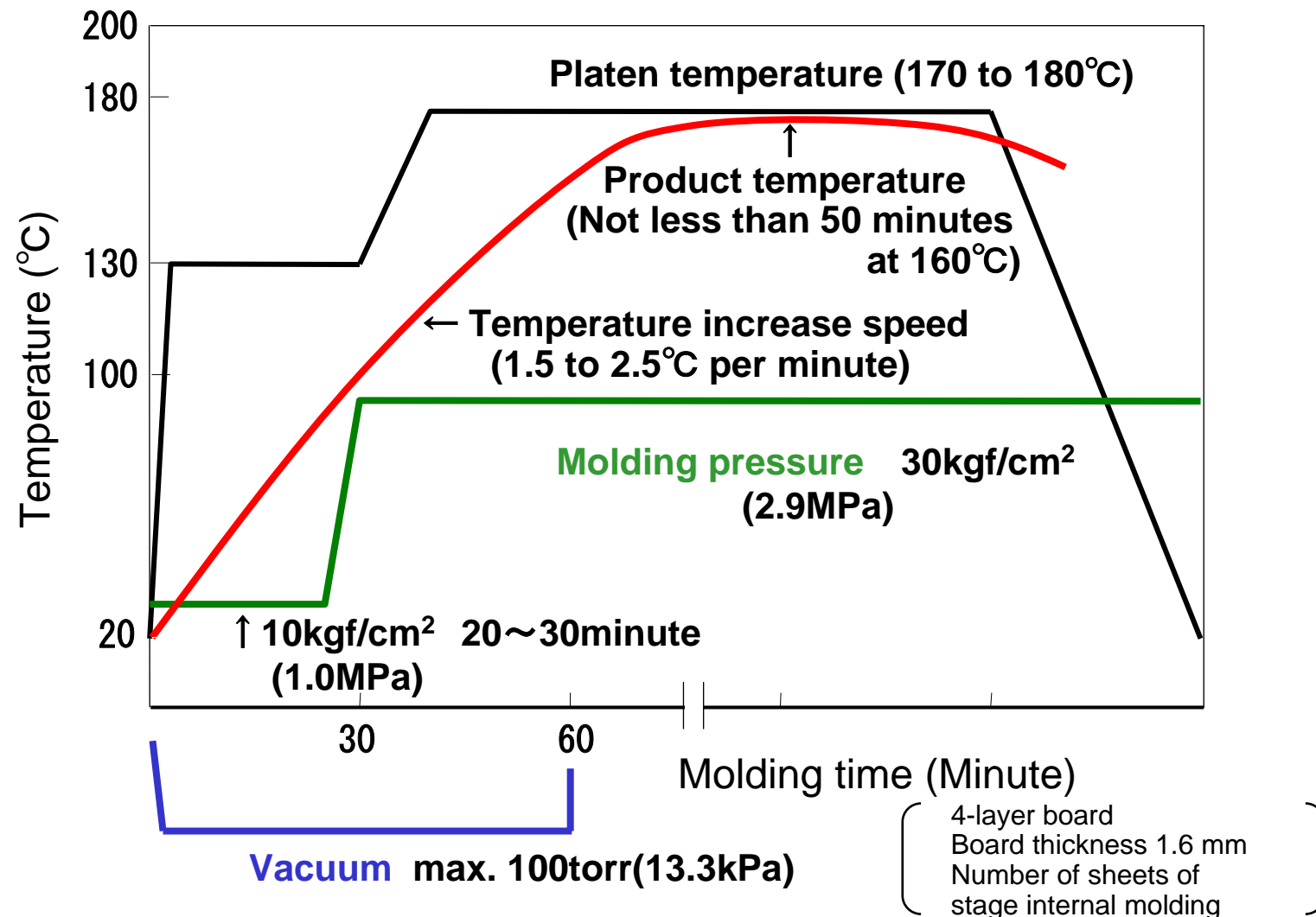
**Better than A-company's halogen-free material
and equivalent to standard FR-4**

		Halogen-free epoxy R-1566	A-company's halogen-free FR-4	Our standard FR-4
Punching quality 1.6 mm at normal temperatures	Surface photograph			
	Cross -sectional photograph			
	Length of crack	0.7 mm	1.3 mm	0.7 mm

The above data are our actual values and not assured values.

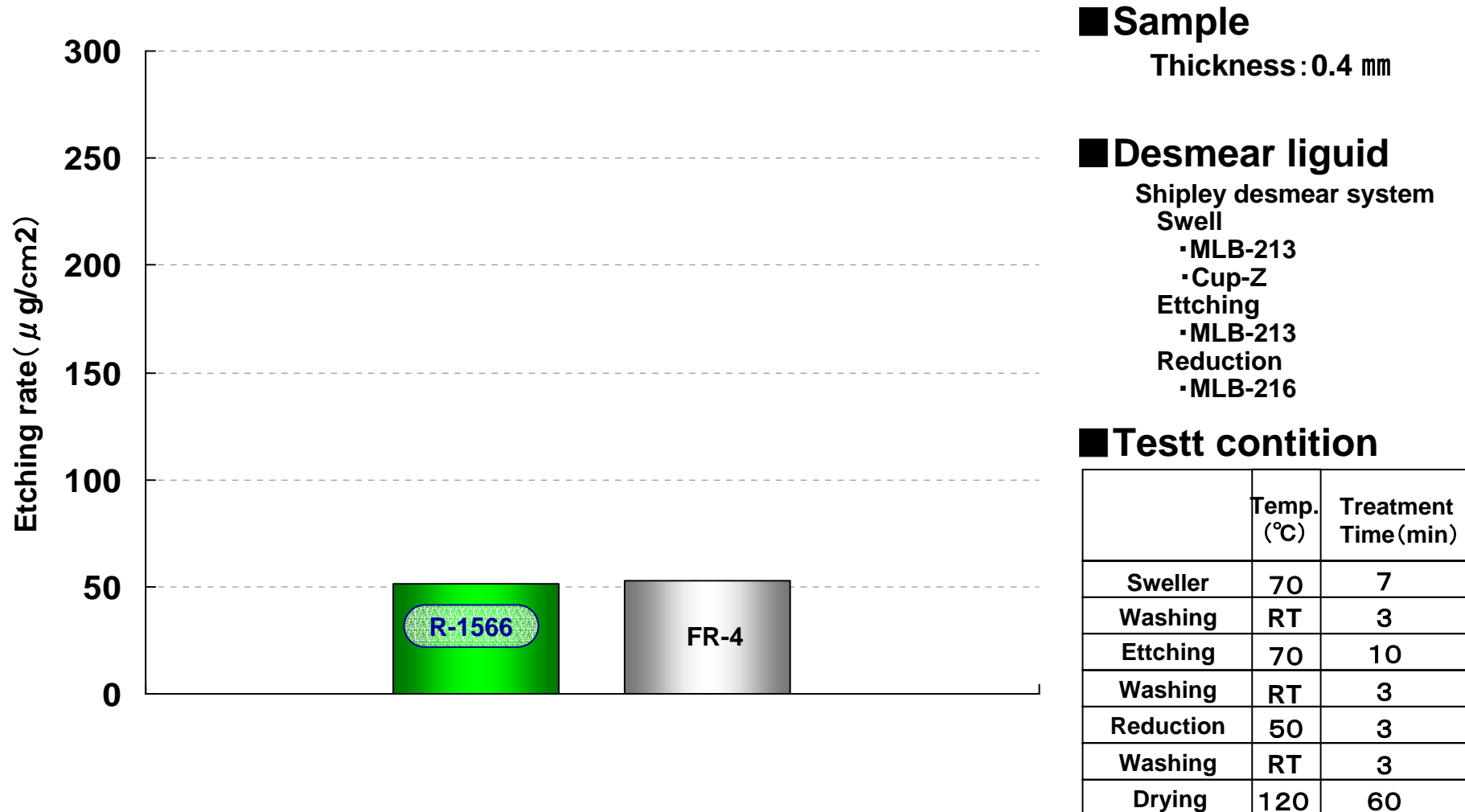
6-(3) Example of molding condition

The molding condition is equivalent to our standard FR-4.



6-(3) Example of Desmear condition (Shipley)

The desmear condition is equivalent to our standard FR-4.



7-(1) Standard characteristics ①

Physical characteristics ①

Item		Condition	Halogen-free epoxy R-1566	Our standard FR-4
Tg(°C)		TMA	145	140
		DSC	148	140
		DMA	180	155
Coefficient of thermal expansion (CTE) ×10 ⁻⁶ /°C	X	Dilatometric method	10~14	10~14
	Y		12~16	12~16
	Z	TMA method	40	65
			180	270
Modulus of flexural (kN/cm ²)	Vertical	25°C	2400	2300
	Horizontal		2200	2100
Poisson's ratio		50°C	0.2	0.2
Thermal conductivity(w/m°C)		25°C	0.62	0.38
Specific heat(J/kg°C)			950	920

The above data are our actual values and not assured values.

7-(1) Standard characteristics ②

Physical characteristics ②

Item		Condition		Halogen-free epoxy R-1566	Our standard FR-4
Peel strength (kN/m)	External layer (18 μm)	Normal condition	25°C	1.47	1.57
			180°C	0.60	0.41
Flame resistance		UL94		94V-0	94V-0
Dimensional variation ratio (0.8 mm)	E-1.0/170	Vertical		-0.0215	-0.0140
		Horizontal		-0.0231	-0.0193
Water absorption rate (1.6mm)		E-24/50+D-24/23		0.06	0.06
Ultraviolet permeability (0.2 mm)	350nm		0.58	26.97	
	420nm		22.54	42.19	

The above data are our actual values and not assured values.

7-(1) Standard characteristics ③

Electric characteristics

Item	Condition	Halogen-free epoxy R-1566	Our standard FR-4
Dk *	1MHz	4.95	4.57
	1GHz	4.70	4.20
Df *	1MHz	0.014	0.020
	1GHz	0.011	0.015
Volume resistance	Normal condition	5×10^7	5×10^7
Surface resistance	Normal condition	5×10^8	5×10^8
Insulation resistance	Normal condition	1×10^8	1×10^8
Flatwise dielectric strength(kV/mm)	Normal condition	64	70
Edgewise dielectric strength(kV/mm)	Normal condition	49	52
Tracking resistance CTI value	IEC method	500	200

* The thickness of a test piece is 0.2 mm.

The above data are our actual values and not assured values.