

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-1566

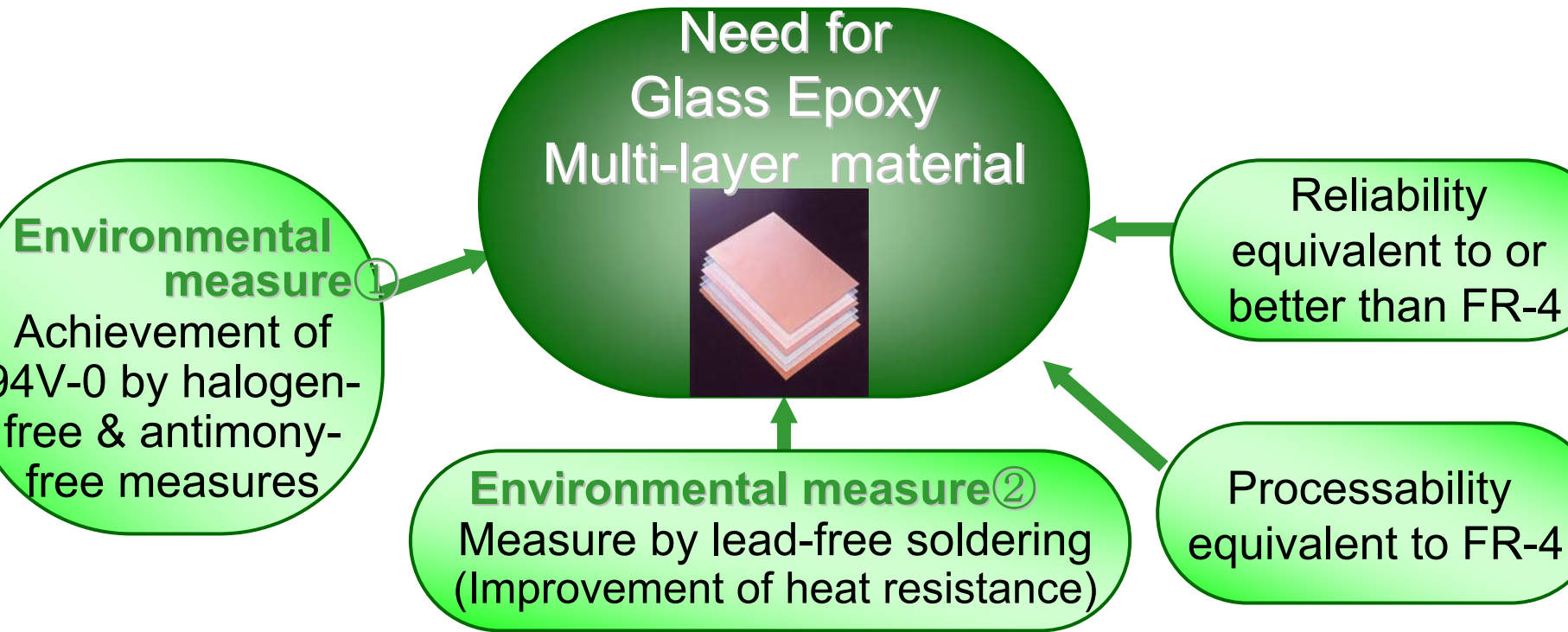
P r e p r e g : R-1551

Jun 18, 2002

Matsushita Electric Works, Ltd.

Electronic Materials Division

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◆ 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

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.

Equivalent to standard FR-4

Evaluation result

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

Evaluation sample

— Cu : 18 μm

..... PP : 0.2mm

Core material : 0.2mm
35

..... PP : 0.2mm

— Cu : 18 μm

Internal layer's treatment
: B/O

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

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

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)

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

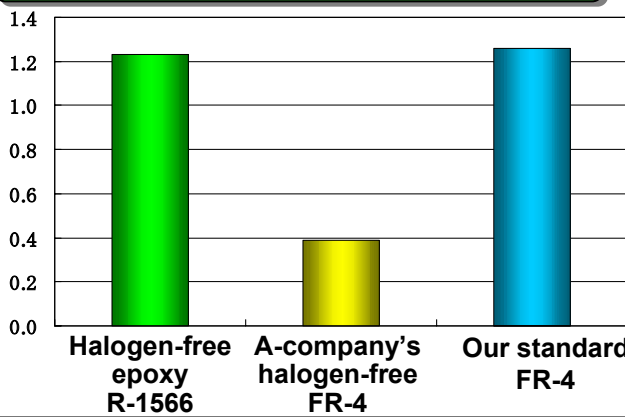
The above data are our actual values and not assured values.

NAIS 4- (1) Inner layer's peeling strength

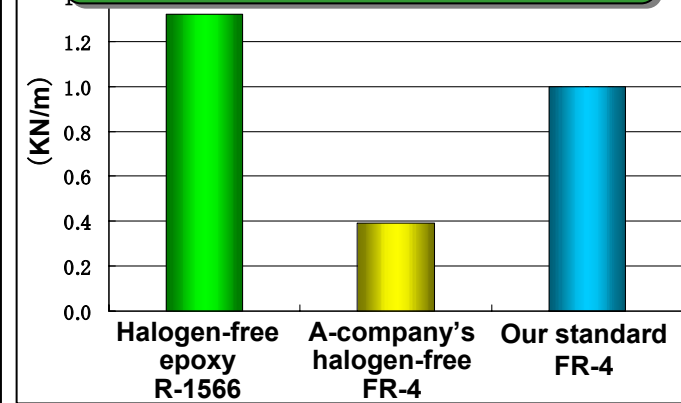
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Not less than 3 times as strong as A-company's halogen-free material (Black oxide treatment, MD treatment)

Black oxide treatment

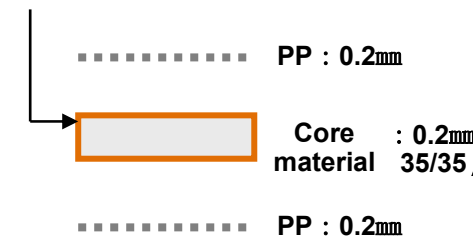


MD treatment (MacDiarmid multi-bond)

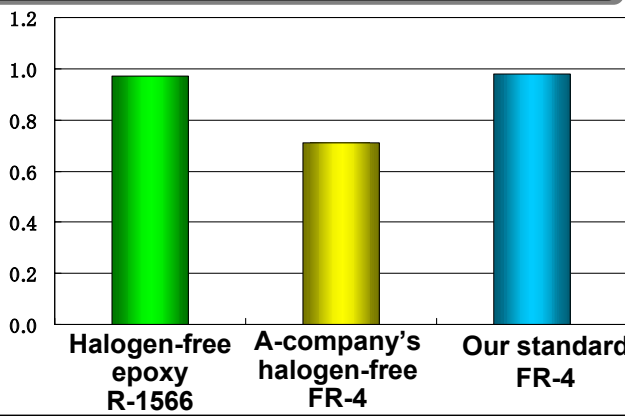


■ Evaluation sample

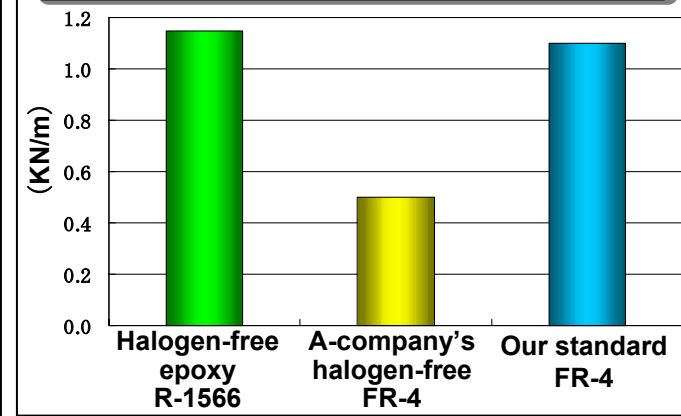
Measurement point of internal layer's peeling



CZ treatment (Mec company)



Reduction treatment



■ Internal layer treatment

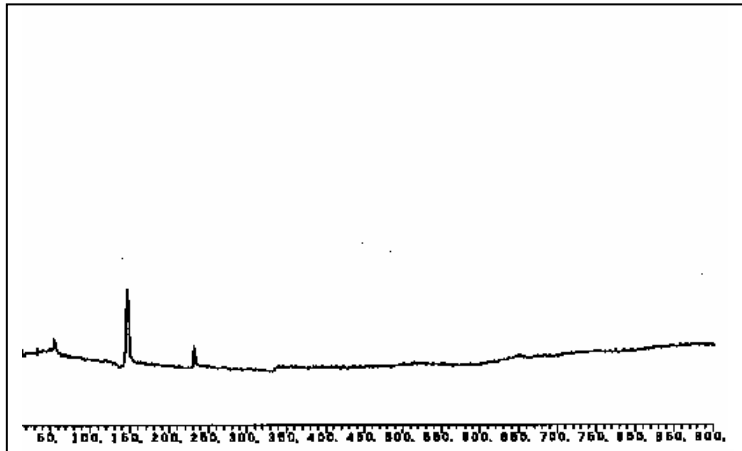
- Black oxide treatment
- MD treatment
- CZ treatment
- Reduction treatment

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

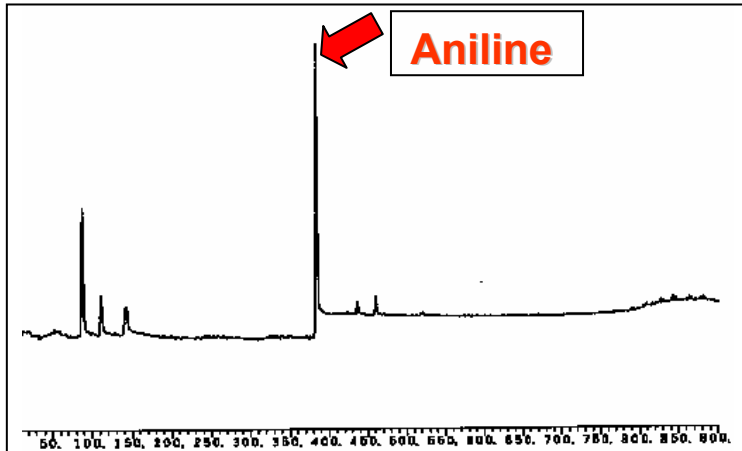
Zero (0) emission of highly poisonous aniline

■ 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.

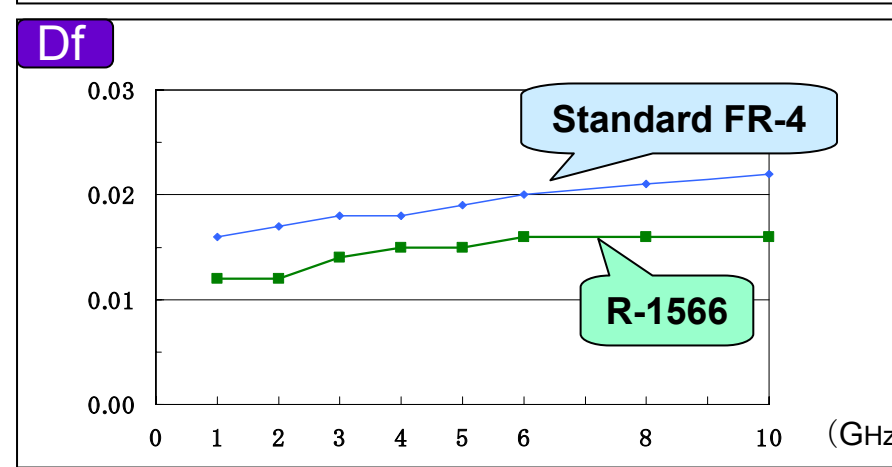
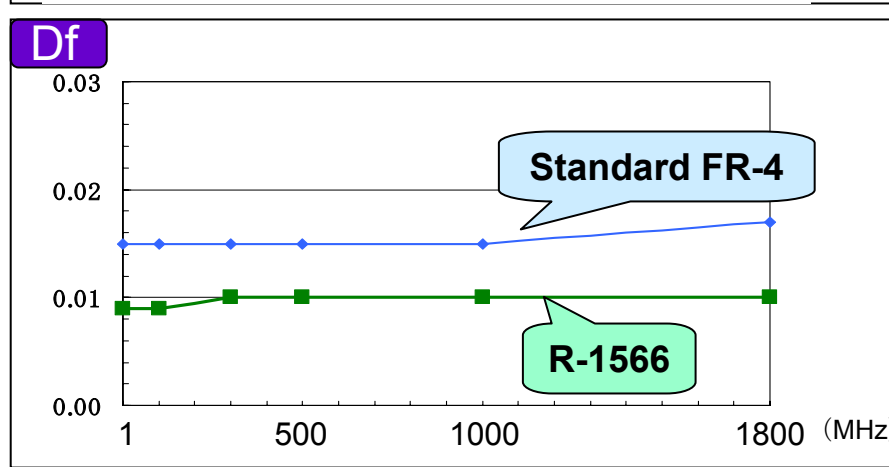
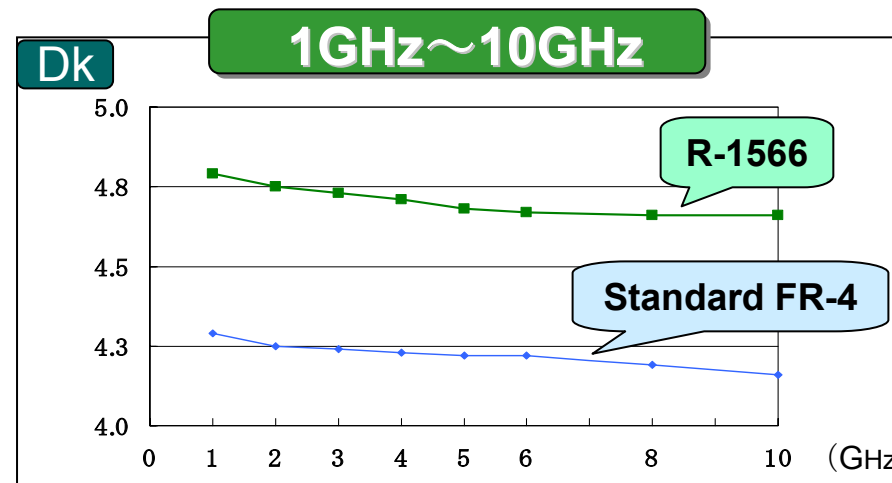
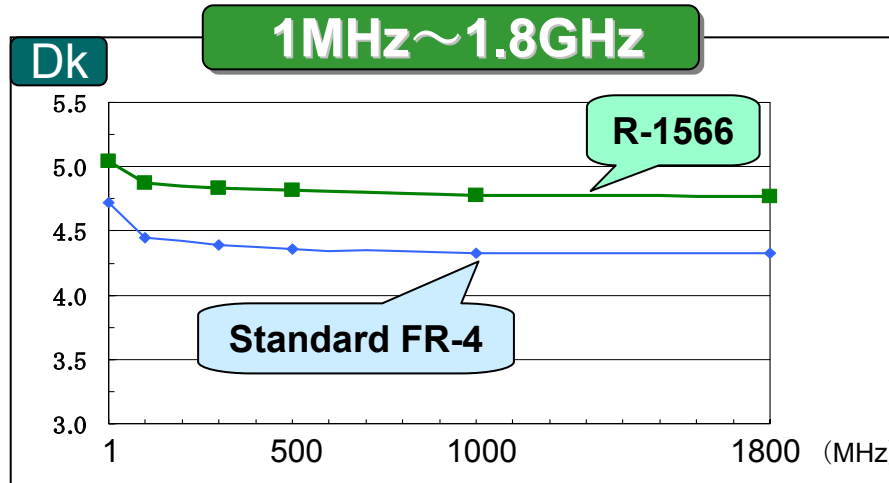
What is aniline?

CAS No 62-53-3
 ■ 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.

Frequency dependence (Room temperature)

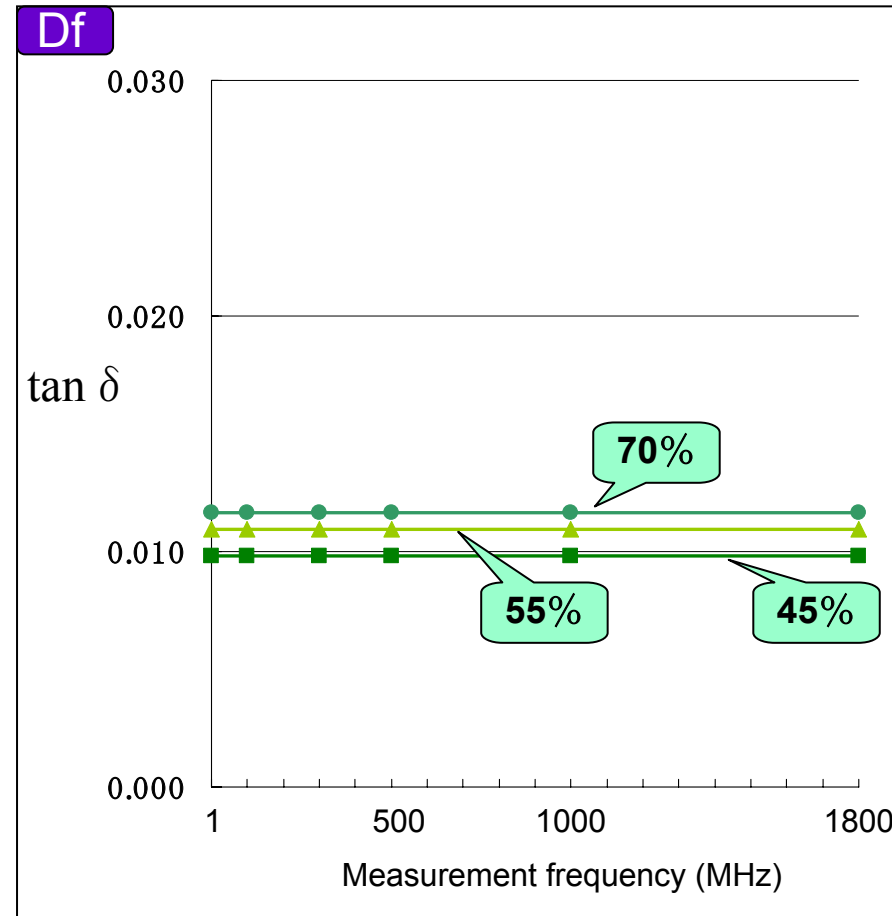
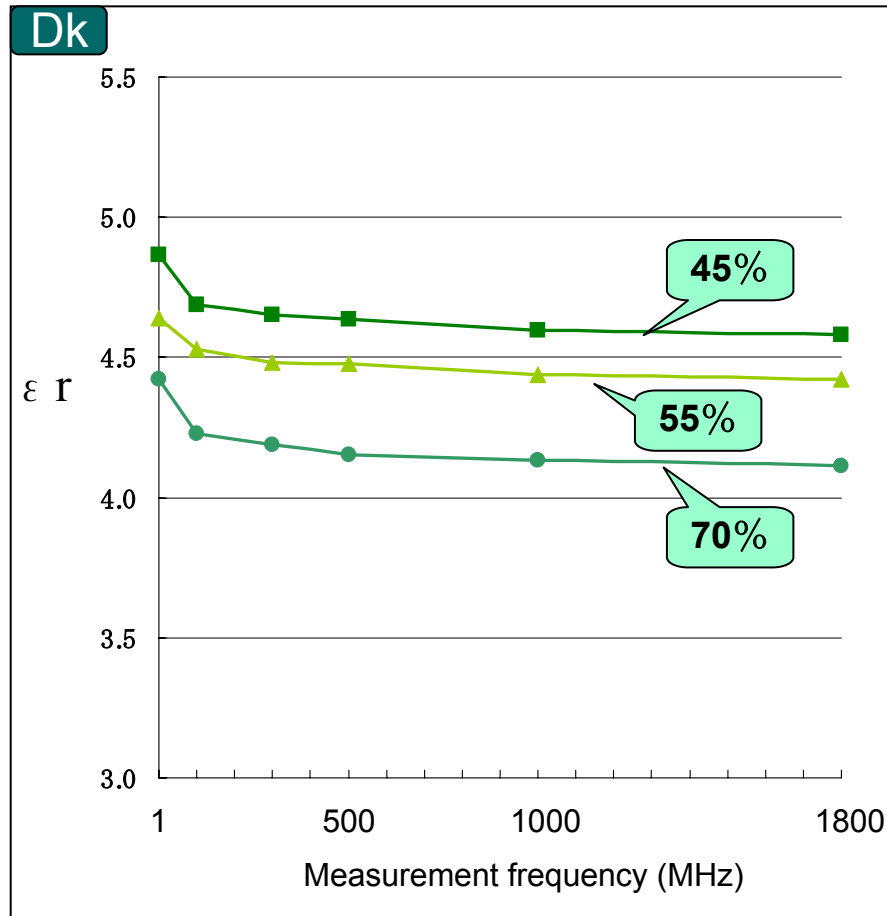


Method of measurement: Volumetric method
(Impedance/material analyzer method)
(According to IPC TM-650 2.5.5.9)

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.

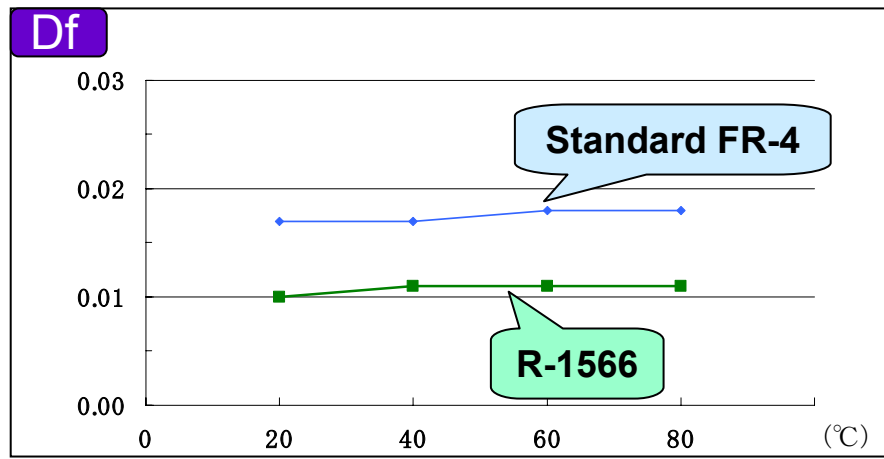
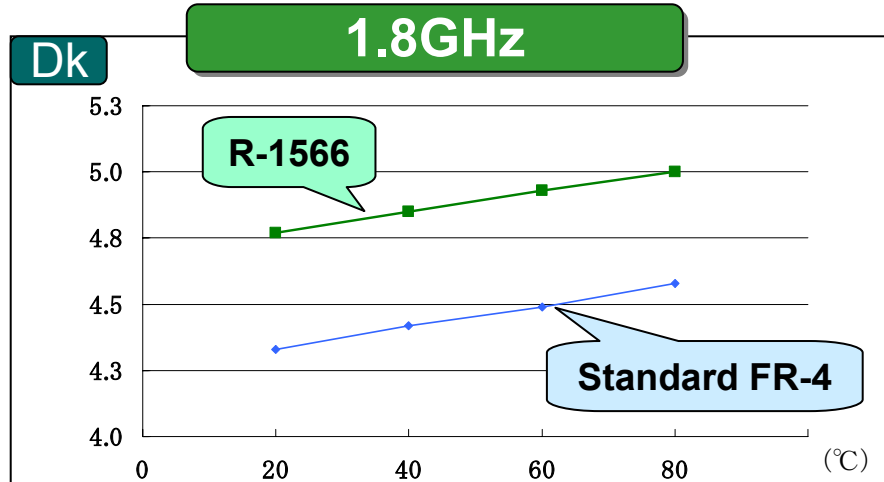
Dielectric characteristics by the volume of resin (Halogen-free material R1566)



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

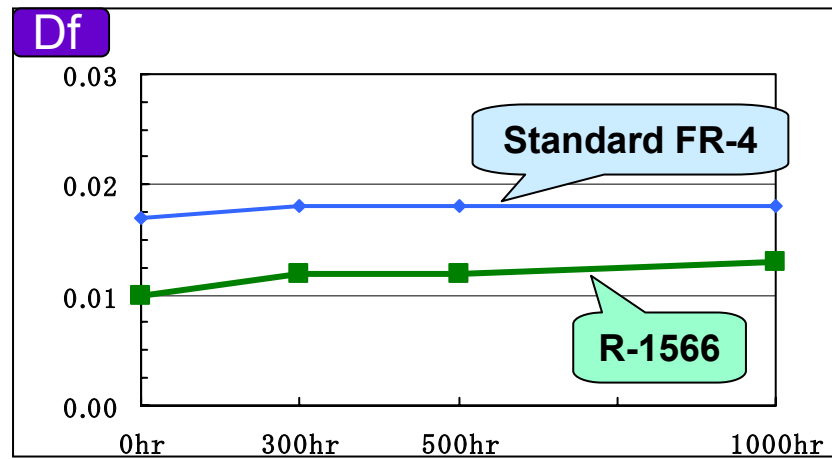
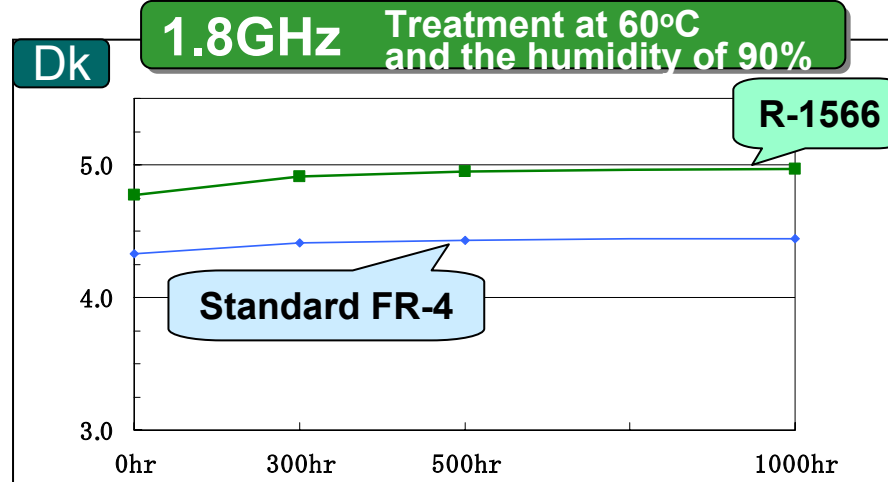
The above data are our actual values and not assured values.

Temperature dependence



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

Humidity dependence

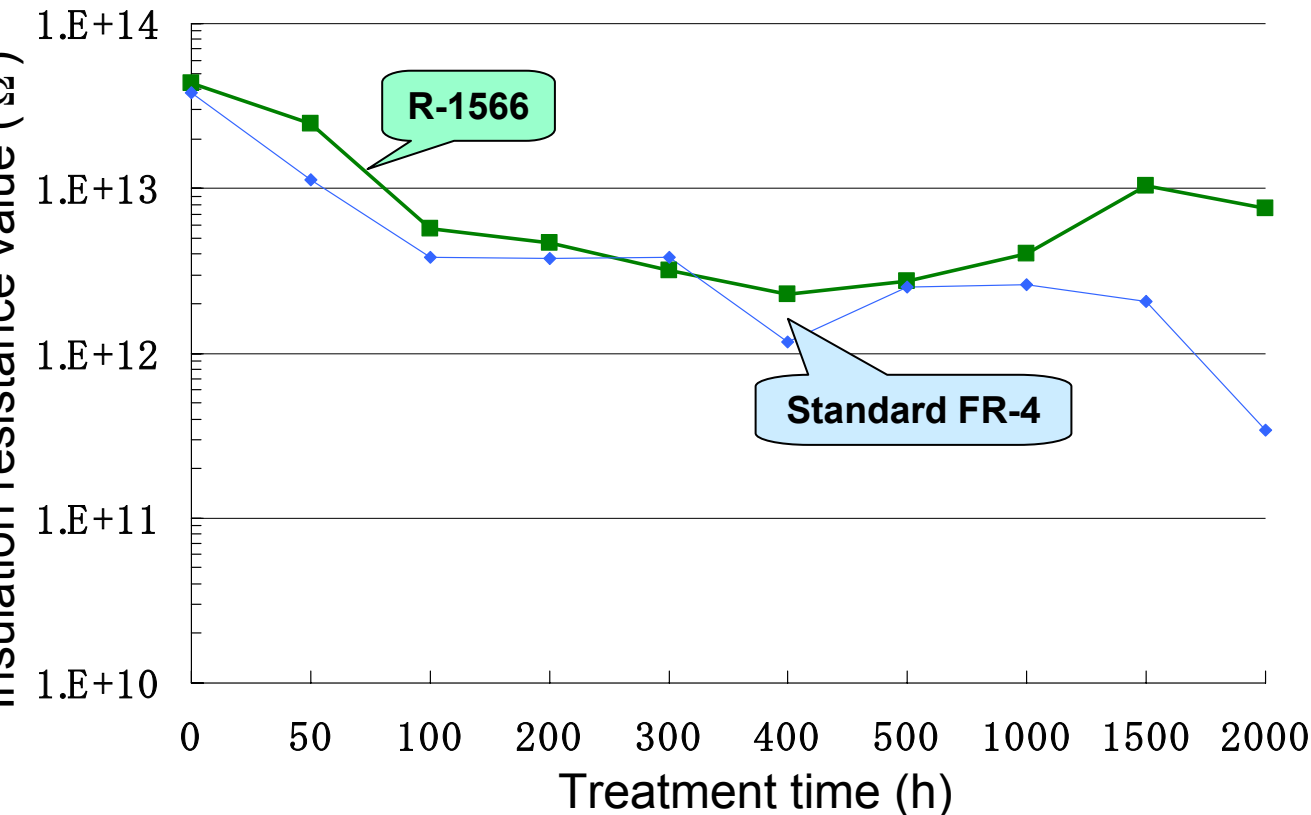


Method of measurement: Volumetric method
(Impedance/material analyzer method)
(According to IPC TM-650 2.5.5.9)

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

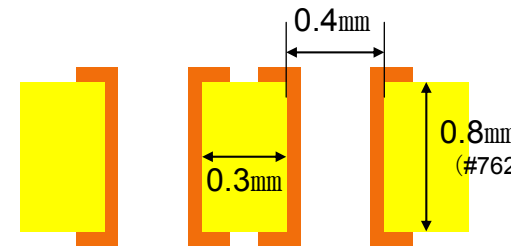
Achievement of 2000 hours with the application of 50V DC at 85°C and the relative humidity of 85%

Evaluation result



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

Evaluation sample



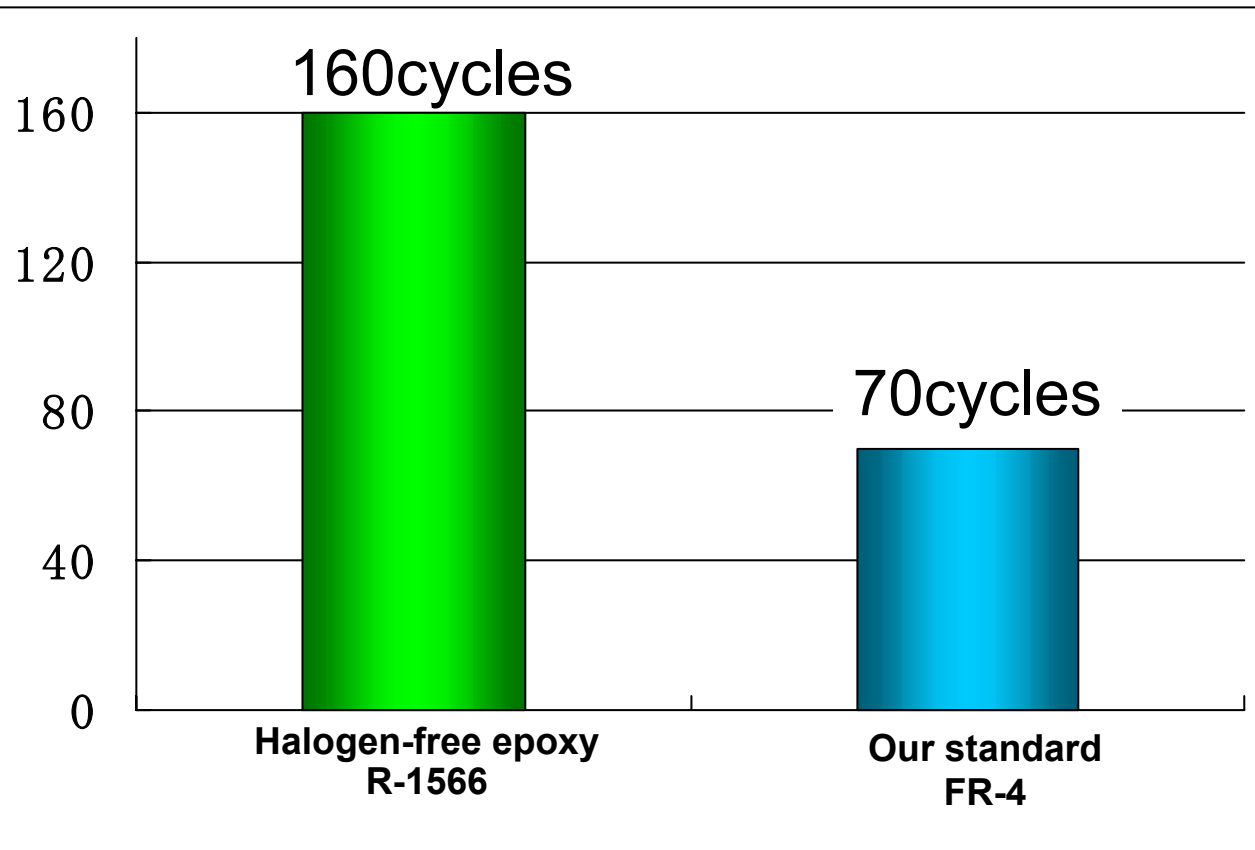
Distance between hole walls : 0.3 mm
 Hole diameter : 0.4 mm
 Board thickness: 0.8 mm

Treatment condition

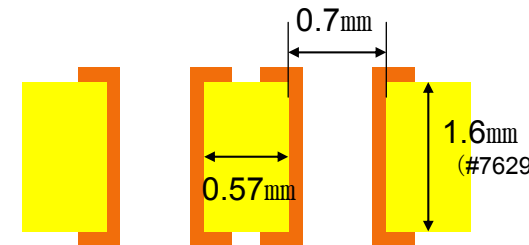
Applies 50 V DC for 1 minute at 85°C and the relative humidity of 85%.

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.

Equivalent to standard FR-4








Evaluation result

Feed speed		2.2m /m in [Standard]		2.6m /m in		3.0m /m in	
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
	Maximum	60	57	60	60	58	60
*1 (μm)							
Hole wall roughness (45 \circ bias) (μm)	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.


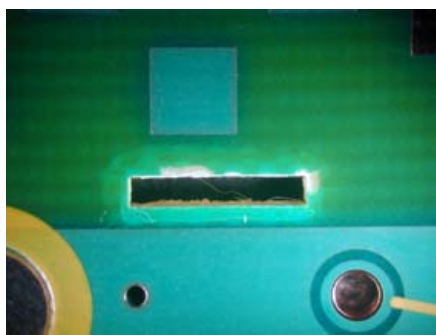

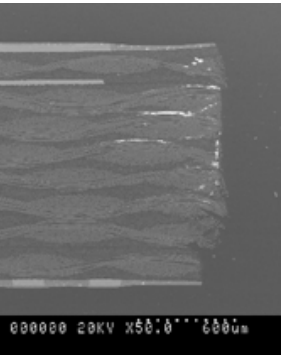
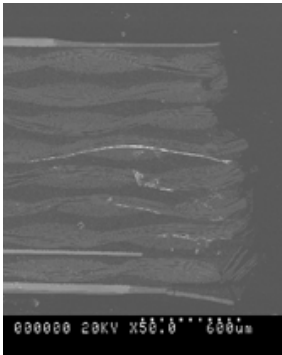
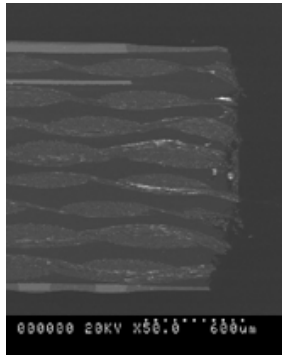
Evaluation sample

	Cu : 18 μm
	PP : 0.1mm
	Core material : 0.2mm (70%) 18/18 μm
	PP : 0.1mm
	Core material : 0.2mm (70%) 18/18 μm
	PP : 0.1mm
	Cu : 18 μm

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 /m in Φ 8.3 μm /rev
	2.6m /m in Φ 1.7 μm /rev
	3.0m /m in Φ 5.0 μm /rev
Upper board	LE300
Lower board	Baking board
Step drilling	Nil
Bush diameter	ϕ 3.175mm

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

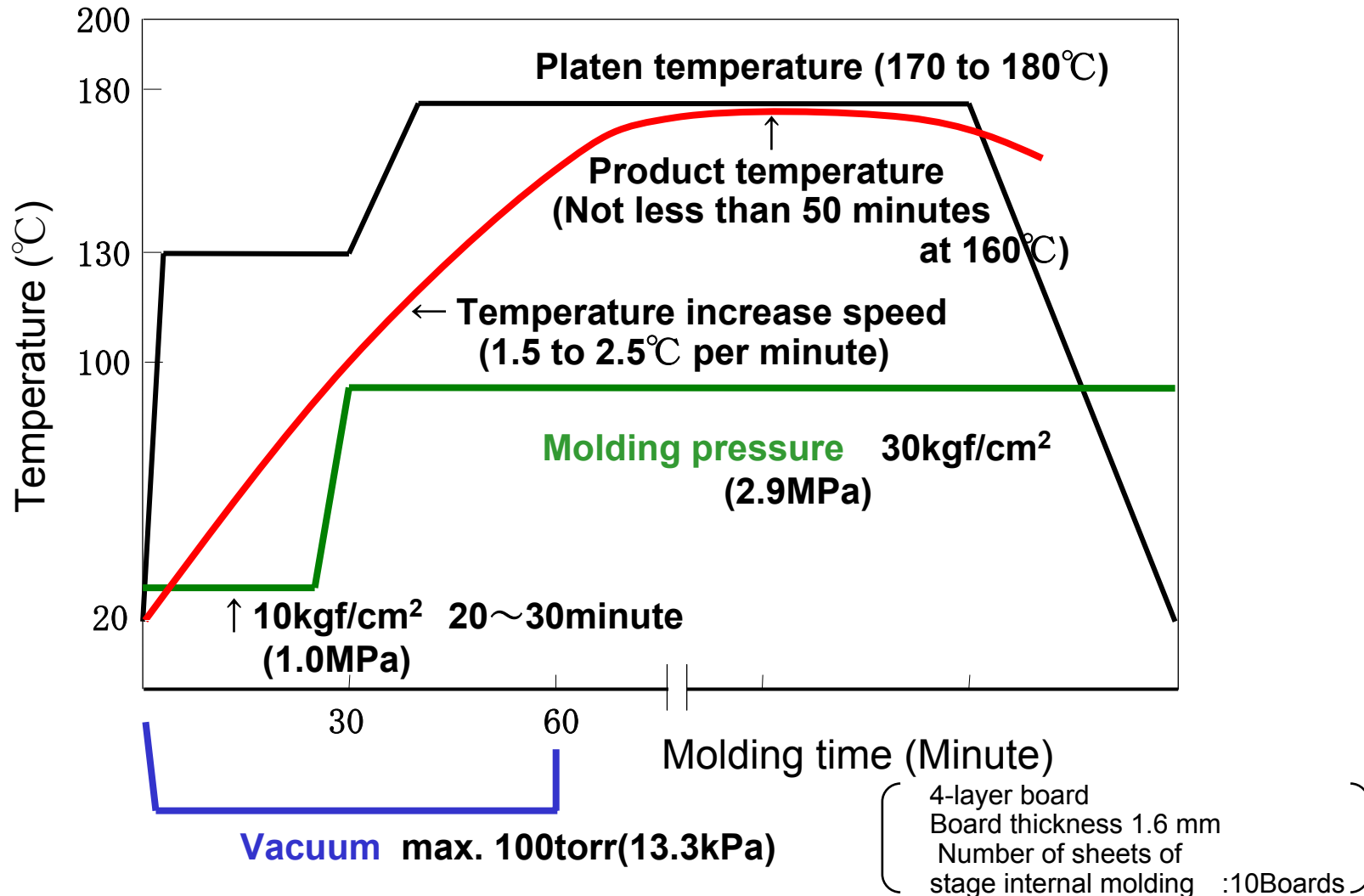
		Halogen-free epoxy R-1566	A-company's halogen-free FR-4	Our standard FR-4
Punching quality 1.6 mm at normal temperatures	Surface photograph			
	Cross -sectional photograph	 <small>000000 20KV X50.0***000um</small>	 <small>000000 20KV X50.0***000um</small>	 <small>000000 20KV X50.0***000um</small>
	Length of crack	0.7 mm	1.3 mm	0.7 mm

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

NAIS 6- (3) Example of molding condition

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



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	
	Y			12~16	
	Z	α 1	TMA method	40	65
		α 2		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.

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.

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.

Copper-clad laminate: R-1566

Nominal thickness (mm) *1	Copper foil	Structure (Glass cloth)	Thickness tolerance (mm)
0.06	12 μ m 18 μ m 35 μ m 70 μ m	1080×1	±0.02
0.1		2116×1	±0.03
0.2		7628×1 (K type) 2116×2	±0.04
0.3		1501×1	±0.05
0.4		7628×2	±0.06
0.5		7628×2 2116×1	±0.07
0.6		7628×3	±0.08
0.8		7628×4	±0.09
1.0		7628×5 (Copper foil of 35 μ m)	±0.11
1.2		7628×6 (Copper foil of 35 μ m)	±0.11
1.6		7628×8 (Copper foil of 35 μ m)	±0.13

* The values of less than 0.8 mm do not include the thickness of copper foil,
and those of not less than 0.8 mm show the total thickness including the thickness of copper foil.

Prepreg: R-1551

Nominal thickness (mm)	Style of glass cloth	Classification (Suffix)	Prepreg Properties			
			Resin content (%)	Volatile content (%)	Gel time (秒)*1	Resin flow (%)
0.06	1080	GG	71±5	Not more than 0.85	135±45	43±7
0.10	2116	GG	55±3	Not more than 0.70	135±45	33±7
0.15	1501	GG	54±3		135±45	33±7
0.2	7628	GG	53±3		110±45	33±7

* 1 When measured at 170°C.