



TEST REPORT

CLIENT: IPC Validation Services

REFERENCE: IPC-4101E/41, IPC-TM-650 2.4.8, 2.4.8.3, 2.5.17.1, 2.6.2.1, 2.5.6, 2.5.5.9, 2.4.4, 2.4.4.1, 2.5.1, 2.4.13.1, 2.5.6.2, 2.4.24, 2.4.39, 2.3.1.1, 2.6.16, IPC J-STD-003C, UL94, Customer Technical Requirement

TEST ITEM: Peel Strength, Volume Resistivity and Surface Resistivity, Moisture Absorption, Dielectric Breakdown, Permittivity and Loss Tangent at 1 MHz, Flexural Strength, Arc Resistance, Thermal Stress, Electric Strength, Horizontal Burning Test, Glass Transition Temperature (TMA), Dimensional Stability, Solderability, Metal Surface Cleanability, Pressure Cooker Test

SAMPLE: CCL

REPORT No.: 17931EG (Instead of 17931E)

TEST RESULTS:

The samples were tested by the indicated test methods within this report. Actual detailed test results are enclosed.



"INTEGRITY, HONESTY AND KNOWLEDGE"

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Test Results

Test Item	Thin	Thick
Peel Strength	Pass	Pass
Volume Resistivity	Pass	Pass
Surface Resistivity	Pass	Pass
Moisture Absorption	/	Pass
Dielectric Breakdown	/	Pass
Permittivity at 1 MHz	Pass	Pass
Loss Tangent at 1 MHz	Pass	Pass
Flexural Strength	/	Pass
Arc Resistance	Pass	Pass
Thermal Stress	Pass	Pass
Electric Strength	Pass	/
Horizontal Burning Test	Pass	Pass
Glass Transition Temperature (TMA)	/	Pass
Dimensional Stability	Pass	Pass
Solderability	Pass	Pass
Metal Surface Cleanability	/	See test page
Pressure Cooker Test	/	See test page



Report Number: 17931EG

SUBMISSION IDENTIFICATION

The following sample(s) were submitted and confirmed by customer:

Test Samples Submitted: 2018-02-05

Sample Designation	Sample Identification	D/C	Sample Quantity
CCL	85N	/	/

Client: IPC Validation Services**Address:** 3000 Lakeside Drive Suite 105N Bannockburn, IL 60015**Attention:** Mr. Randy Cherry**Phone:** +1-847-597-2806



Peel Strength

SPECIMENS

A minimum of two 0.79 mm and two 3.18mm test strips per specimen shall be peeled.

REFERENCE

IPC-TM-650 Method 2.4.8 Peel Strength of Matallic Clad Laminates
IPC-TM-650 Method 2.4.8.3 Peel Strength of Matallic Clad Laminates at Elevated
IPC-4101E Specification for Base Materials for Rigid and Multilayer Printed Boards

METHOD/ REQUIREMENT

After Thermal Stress

Apply a thin coating of silicon grease to specimens and float on solder maintained at $288^{\circ}\text{C} \pm 5.5^{\circ}\text{C}$ for 10^{+1}_{-0} s.

At Elevated Temperature

Specimens shall be preconditioned by baking at 125°C for $4\text{h} \pm 0.5\text{h}$, and then place the specimens to remain in the heated chamber for 60^{+6}_{-0} min before performing the peel test at 125°C .

After Process Solution

Immerse the samples in organic stripper as specified in Methylene Chloride for $75\text{s} \pm 5\text{s}$ at $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$.

Dry the samples $15\text{min} \pm 5\text{min}$ at $125^{\circ}\text{C} \pm 5^{\circ}\text{C}$.

Immerse in a solution of 10 g/L sodium hydroxide at $90^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for $5\text{min} \pm 1\text{min}$.

Rinse in hot tap water at $50^{\circ}\text{C} \sim 55^{\circ}\text{C}$ for $5\text{min} \pm 1\text{min}$.

Immerse for $30\text{min} \pm 5\text{min}$ in a solution of 10g/L sulfuric acid and 30g/L boric acid solutions at $60^{\circ}\text{C} \pm 5^{\circ}\text{C}$.

Rinse in hot water at $55^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for $5\text{min} \pm 1\text{min}$.

Dry for $30\text{min} \pm 5\text{min}$ at $125^{\circ}\text{C} \pm 5^{\circ}\text{C}$.

Immerse in a hot oil bath maintained at $220^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for $40\text{s} \pm 5\text{s}$.

Immerse in degreaser as specified in isopropyl alcohol, at $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ for $75\text{s} \pm 5\text{s}$ to remove hot oil.

Air dries the specimens.

Examine the specimens using normal or corrected 20/20 vision. Record and report the presence of any base laminate degradation, including loss of surface resin, discoloration, resin softening, delamination, blistering, propagation of imperfections, measling, crazing, or voids.

Peel the test strip back at the tab end (if present) no more than 12.7 mm. Attach the clamp to the peeled back end of the test strip. Start tester and apply force in the vertical direction at the rate of 50.8 mm/min, until at least a 25.4 mm peel is completed.

Calculate the peel strength as per the formula:

$$N/\text{mm} = L_M/W_S$$



Where:

L_M = Minimum Load in N

W_S = Measured width of peel strip in mm

RESULTS

The samples were tested by the methods given above. The test results meet the requirements of IPC-4101E/41 standards. See attached test data sheets for actually test result.

Table 1 Peel Strength Thin (After Thermal Stress)				
Sample Designation	CCL	Sample Identification	85N	
Test Date	2018-02-08	Ambient	25°C, 46%RH	
Sample No.	Peel Strength (N/mm)			
	A Crosswise	A Lengthwise	B Crosswise	B Lengthwise
17930-86-1	0.94			
17930-86-2	0.95			
17930-87-1		0.96		
17930-87-2		0.95		
17930-88-1			0.92	
17930-88-2			0.91	
17930-89-1				0.93
17930-89-2				0.94
Average	0.95		0.92	
Requirement	≥ 0.70			

**Table 2 Peel Strength Thick (After Thermal Stress)**

Sample Designation	CCL	Sample Identification	85N	
Test Date	2018-02-08	Ambient	25°C, 46%RH	
Sample No.	Peel Strength (N/mm)			
	A Crosswise	A Lengthwise	B Crosswise	B Lengthwise
17930-1-1	1.27			
17930-1-2	1.29			
17930-2-1		1.28		
17930-2-2		1.31		
17930-3-1			1.26	
17930-3-2			1.25	
17930-4-1				1.26
17930-4-2				1.28
Average	1.29		1.26	
Requirement	≥ 0.80			

Table 3 Peel Strength Thin (At Elevated Temperature)

Sample Designation	CCL	Sample Identification	85N	
Test Date	2018-02-09	Ambient	24°C, 49%RH	
Sample No.	Peel Strength (N/mm)			
	A Crosswise	A Lengthwise	B Crosswise	B Lengthwise
17930-90-1	0.83			
17930-90-2	0.86			
17930-91-1		0.83		
17930-91-2		0.84		
17930-92-1			0.82	
17930-92-2			0.82	
17930-93-1				0.81
17930-93-2				0.80
Average	0.84		0.81	
Requirement	≥ 0.60			

**Table 4 Peel Strength Thick (At Elevated Temperature)**

Sample Designation	CCL	Sample Identification	85N	
Test Date	2018-02-09	Ambient	24°C, 49%RH	
Sample No.	Peel Strength (N/mm)			
	A Crosswise	A Lengthwise	B Crosswise	B Lengthwise
17930-5-1	1.08			
17930-5-2	1.05			
17930-6-1		1.04		
17930-6-2		1.03		
17930-7-1			1.08	
17930-7-2			1.08	
17930-8-1				1.02
17930-8-2				1.04
Average	1.05		1.06	
Requirement	≥ 0.70			

Table 5 Peel Strength Thin (After Process Solutions)

Sample Designation	CCL	Sample Identification	85N	
Test Date	2018-02-09	Ambient	24°C, 49%RH	
Sample No.	Peel Strength (N/mm)			
	A Crosswise	A Lengthwise	B Crosswise	B Lengthwise
17930-94-1	0.83			
17930-94-2	0.83			
17930-95-1		0.91		
17930-95-2		0.94		
17930-96-1			0.85	
17930-96-2			0.86	
17930-97-1				0.92
17930-97-2				0.93
Average	0.88		0.89	
Requirement	≥ 0.60			

**Table 6 Peel Strength Thick (After Process Solutions)**

Sample Designation	CCL	Sample Identification	85N	
Test Date	2018-02-09	Ambient	24°C, 49%RH	
Sample No.	Peel Strength (N/mm)			
	A Crosswise	A Lengthwise	B Crosswise	B Lengthwise
17930-9-1	1.25			
17930-9-2	1.21			
17930-10-1		1.18		
17930-10-2		1.19		
17930-11-1			1.28	
17930-11-2			1.23	
17930-12-1				1.20
17930-12-2				1.26
Average	1.21		1.24	
Requirement	≥ 0.70			

Table 7 Peel Strength Thin (Low Profile Copper Foil)

Sample Designation	/	Sample Identification	/	
Test Date	/	Ambient	/	
Sample No.	Peel Strength (N/mm)			
	A Crosswise	A Lengthwise	B Crosswise	B Lengthwise
No Requirement for IPC-4101E/41				



Table 8 Peel Strength Thick (Low Profile Copper Foil)

Sample Designation	/	Sample Identification	/	
Test Date	/	Ambient	/	
Sample No.	Peel Strength (N/mm)			
	A Crosswise	A Lengthwise	B Crosswise	B Lengthwise
No Requirement for IPC-4101E/41				



Volume and Surface Resistivity

TEST SPECIMEN

Laminate thickness of 0.50 mm or greater, three specimens of dimensions (101.6 ± 3.2) mm x (101.6 ± 3.2) mm by thickness shall be prepared for each test condition, unless otherwise specified.

Laminate thickness of less than 0.50 mm, three specimens of dimensions (50.8 ± 1.6) mm x (50.8 ± 1.6) mm by thickness shall be prepared for each test condition, unless otherwise specified.

REFERENCE

IPC-4101E Specification for Base Materials for Rigid and Multilayer Printed Boards
IPC-TM-650 2.5.17.1 Volume and Surface Resistivity of Dielectric Materials

METHOD/ REQUIREMENT

Humidity Conditioning

Specimens of a thickness less than 0.50 mm shall be subjected to 90^{+5}_{-0} % relative humidity and $35^{\circ}\text{C} \pm 2^{\circ}\text{C}$ for a period of 96^{+2}_{-0} hours prior to electrical measurement.

Specimens of a thickness greater than, or equal to 0.50 mm shall be subjected to 20 cycles of temperature ranging from 25^{+5}_{-2} °C to (65 ± 2) °C, 85% to 93% relative humidity, 160 hours total. Electrical measurements taken shall be made after achieving 1.5 hours steady state of (25 ± 2) °C and 90^{+5}_{-0} % relative humidity. All measurements shall be completed within 2 hours.

At Elevated Temperature Conditioning

Specimens shall be subjected to 204°C for a period of 24^{+2}_{-0} hours.

Electrical measurements taken shall be completed within the 2 hours tolerance of the conditioning.

All electrical measurements shall be made using 500 volts direct current. The voltage shall be applied to the specimen for 60^{+5}_{-0} seconds prior to taking the actual reading.

The volume resistivity shall be calculated as follows:

$$r = RA/T$$

Where: r = Volume resistivity in megohm-centimeters

R = Measured volume resistance in megohms

A = Effective area of the guarded electrode in square centimeters

T = Average thickness of specimen in centimeters

The surface resistivity shall be calculated as follows:

$$r' = R'P/D4$$

Where: r' = Surface resistivity in megohms

R' = Measured surface resistance in megohms

P = Effective perimeter of the guarded electrode in centimeters

D4 = Width of the test gap in centimeters

**RESULTS**

The samples were tested by the methods given above. The test results meet the requirements of IPC-4101E/41 standards. See attached test data sheets for actually test result.

Table 9 Volume and Surface Resistivity Thin (Humidity Conditioning)

Sample Designation	CCL		Sample Identification	85N	
Test Date	2018-02-07~2018-02-11		Ambient	23°C, 49%RH	
Sample No.	Average Thickness T	Surface Resistance R'	Surface Resistivity $r'=RP/D_4$	Volume Resistance R	Volume Resistivity $r=RA/T$
	(cm)	(MΩ)	(MΩ)	(MΩ)	(MΩ-cm)
17930-119-1	0.0211	3.6E+05	1.2E+08	5.0E+05	1.2E+08
17930-119-2	0.0213	2.6E+05	8.4E+07	4.4E+05	1.1E+08
17930-119-3	0.0213	2.0E+05	6.4E+07	3.4E+05	8.2E+07
Average		/	8.8E+07	/	1.0E+08
Requirement		/	≥1.0E+04	/	≥6.0E+04



Table 10 Volume and Surface Resistivity Thin (At Elevated Temperature)

Sample Designation	CCL		Sample Identification	85N	
Test Date	2018-02-08~2018-02-09		Ambient	22°C, 49%RH	
Sample No.	Average Thickness T	Surface Resistance R'	Surface Resistivity $r=R'P/D_4$	Volume Resistance R	Volume Resistivity $r=RA/T$
	(cm)	(MΩ)	(MΩ)	(MΩ)	(MΩ-cm)
17930-120-1	0.0213	1.6E+07	5.2E+09	5.6E+07	1.4E+10
17930-120-2	0.0215	3.8E+07	1.2E+10	8.0E+07	1.9E+10
17930-120-3	0.0210	2.7E+07	8.7E+09	3.0E+07	7.4E+09
Average		/	8.7E+09	/	1.3E+10
Requirement		/	≥1.0E+04	/	≥6.0E+04

**Table 11 Volume and Surface Resistivity Thick (Humidity Conditioning)**

Sample Designation	CCL		Sample Identification	85N	
Test Date	2018-02-06~2018-02-13		Ambient	22°C, 49%RH	
Sample No.	Average Thickness T	Surface Resistance R'	Surface Resistivity $r'=RP/D_4$	Volume Resistance R	Volume Resistivity $r=RA/T$
	(cm)	(MΩ)	(MΩ)	(MΩ)	(MΩ-cm)
17930-73-1	0.1056	1.4E+05	4.0E+06	1.2E+06	2.9E+08
17930-73-2	0.1064	1.8E+05	5.1E+06	1.8E+06	4.3E+08
17930-73-3	0.1065	1.0E+05	2.8E+06	1.4E+06	3.4E+08
Average		/	4.0E+06	/	3.5E+08
Requirement		/	≥1.0E+06	/	≥1.0E+06

Table 12 Volume and Surface Resistivity Thick (At Elevated Temperature)

Sample Designation	CCL		Sample Identification	85N	
Test Date	2018-02-08~2018-02-09		Ambient	22°C, 49%RH	
Sample No.	Average Thickness T	Surface Resistance R'	Surface Resistivity $r'=RP/D_4$	Volume Resistance R	Volume Resistivity $r=RA/T$
	(cm)	(MΩ)	(MΩ)	(MΩ)	(MΩ-cm)
17930-74-1	0.1056	5.0E+07	1.4E+09	4.8E+07	1.2E+10
17930-74-2	0.1059	3.6E+07	1.0E+09	3.2E+07	7.7E+09
17930-74-3	0.1052	2.9E+07	8.2E+08	3.0E+07	7.3E+09
Average		/	1.1E+09	/	8.9E+09
Requirement		/	≥1.0E+06	/	≥1.0E+06



Moisture Absorption

TEST SPECIMEN

The specimens shall be 50.8 mm×50.8 mm by the thickness of the material. Edges shall be smooth.

REFERENCE

IPC-TM-650 Method 2.6.2.1 Water Absorption, Metal Clad Plastic Laminates
IPC-4101E Specification for Base Materials for Rigid and Multilayer Printed Boards

METHOD/ REQUIREMENT

The specimens shall be cleaned by at least three repeated wipings with a clean damp cloth. The specimens were preconditioned by baking for 1 hour, at 105°C to 110°C, cooled to room temperature in a desiccator and weighed immediately upon removal from the desiccator. Record the weight m_1 . Place the samples in the distilled water maintained at $(23\pm 1.1)^\circ\text{C}$ for 24 hours minus 0 plus 30 minutes. The specimens shall be removed from the water one at a time, all surface water removed with a dry cloth and weighed immediately. Record the wet weight m_2 .

$$\text{Increase in weight, percent} = \frac{m_2 - m_1}{m_1} \times 100$$

RESULTS

The samples were tested by the methods given above. The test results meet the requirement of IPC-4101E/41 standards. See attached test data sheet for actually test result.

Table 13 Moisture Absorption

Sample Designation	CCL		Sample Identification	85N
Test Date	2018-02-07~2018-02-08		Ambient	22°C, (49~50)%RH
Sample No.	mass(g)		increasing weight percent of mass(%)	
	m_1	m_2		
17930-19	4.7861	4.8032	0.4	
17930-20	4.9205	4.9382	0.4	
17930-21	4.8735	4.8901	0.3	
Average			0.4	
Requirement			≤ 1.0	



Dielectric Breakdown

SPECIMENS

4 pcs specimens, two lengthwise and two crosswise. The dimension is 76mm×50mm.

REFERENCE

IPC-4101E Specification for Base Materials for Rigid and Multilayer Printed Boards
IPC-TM-650 Method 2.5.6 Dielectric Breakdown

METHOD/ REQUIREMENT

Unless otherwise specified the specimen shall be conditioned for 48 ± 0 hours in distilled water maintained at $50^{\circ}\text{C} \pm 2^{\circ}\text{C}$. Following this step the specimen shall be immersed in ambient temperature distilled water for 30 minutes minimum, 4 hours maximum, to allow the specimens to achieve temperature equilibrium without a substantial change in moisture content.

Remove a preconditioned specimen from the ambient temperature water and wipe dry with a lint free paper towel. Insert the first specimen into the fixture (inserting the tapered pins from opposite sides) and immerse in the oil bath. The leakage current is 5mA. Operate the tester such that the voltage is applied with 500 volts per second rate of rise and observe the specimen until an electrical breakdown occurs.

RESULTS

The samples were tested by the methods given above. The test results meet the requirement of IPC-4101E/41 standards. See attached test data sheet for actually test result.

Table 14 Dielectric Breakdown

Sample Designation	CCL	Sample Identification	85N
Test Date	2018-02-26~2018-02-28	Ambient	21°C, 50%RH
Sample No.	Thickness	Voltage	
	(mm)	(kV)	
18012-24-1	1.047	45.97+N.B.	
18012-24-2	1.045	45.93+N.B.	
18012-24-3	1.046	45.91+N.B.	
18012-24-4	1.044	45.90+N.B.	
Minimum Voltage		46+N.B.	
Requirement		≥40	



Permittivity and Loss Tangent

TEST SPECIMEN

Three specimens shall be 50 mm×50mm by the thickness of the material.

REFERENCE

IPC-TM-650 Method 2.5.5.9 Permittivity and Loss Tangent, Parallel Plate, 1MHz to 1.5 GHz

IPC-4101E Specification for Base Materials for Rigid and Multilayer Printed Boards

METHOD/ REQUIREMENT

The samples were preconditioned by baking for 2 h, at 105°C, cooled to room temperature. All samples shall be conditioned at 23°C±2°C and 50% RH±5%RH for a minimum of 24h prior to testing. Measure the sample thickness. The samples were tested by impedance material analyzer. The samples were tested at 1MHz.

RESULTS

The samples were tested by the methods given above. The test results meet the requirement of IPC-4101E/41 standards. See attached test data sheet for actually test result.

Table15 Permittivity and Loss Tangent				
Sample Designation	CCL		Sample Identification	85N
Test Date	2018-02-06~2018-02-07		Ambient	19°C, 50%RH
Sample No.	test frequency	thickness(mm)	permittivity	loss tangent
17930-25	1MHz	1.061	4.6	0.004
17930-26		1.060	4.5	0.005
17930-27		1.063	4.5	0.004
Average			4.5	0.004
Requirement			≤5.4	≤0.035
17930-101	1MHz	0.218	4.3	0.009
17930-102		0.218	4.3	0.008
17930-103		0.215	4.3	0.008
Average			4.3	0.008
Requirement			≤5.4	≤0.035



Flexural Strength

TEST SPECIMEN

For Flexural Strength Test (At Ambient Temperature): Dimensions of the specimens shall be 63.5mm×25.4mm. Two specimens shall be taken for each direction for lengthwise and crosswise direction of the sample tested.

For Flexural Strength (At Elevated Temperature): Dimensions of the specimens shall be 63.5mm×25.4mm. Four specimens shall be taken for lengthwise direction of the sample tested.

REFERENCE

IPC-TM-650 2.4.4 Flexural Strength of Laminates (at Ambient Temperature)

IPC-TM-650 2.4.4.1 Flexural Strength of Laminates (at Elevated Temperature)

IPC-4101E Specification for Base Materials for Rigid and Multilayer Printed Boards

METHOD/ REQUIREMENT

At Ambient Temperature

Test the specimens at ambient temperature.

At Elevated Temperature

Test after heating specimen within the heat chamber at 204 °C, 1h.

Center the specimen on the supports with the long axis of the specimen perpendicular to the loading nose and supports and stabilize at elevated temperature, then apply the load at the speed of testing until the specimen breaks. Test speed is 0.76mm/min.

Calculate the flexural strength for each specimen:

$$S = \frac{3PL}{2bd^2}$$

S = Flexural strength, N/mm²;

P = Load at breakage, N;

L = Span, mm;

b = Width of specimen, mm;

d = Thickness, mm

RESULTS

The samples were tested by the methods given above. The test results meet the requirement of IPC-4101E/41 standards. See attached test data sheet for actually test result.

**Table 16 Flexural Strength Test (At Ambient Temperature)**

Sample Designation	CCL		Sample Identification		85N		
Test Date	2018-02-08		Ambient		25°C, 46%RH		
Sample No.	Span	Thickness	Width	Load	Flexural Strength $S=3PL/2bd^2$	Average	Requirement
	L	d	b	P			
	(mm)	(mm)	(mm)	(N)			
17930-75-1 (Cross direction)	25.40	1.071	25.27	395.820	520	519	≥325
17930-75-2 (Cross direction)		1.069	25.50	396.051	518		
17930-75-7 (Length direction)		1.072	25.24	489.169	643	645	≥415
17930-75-8 (Length direction)		1.070	25.39	493.938	647		

Table 17 Flexural Strength (At Elevated Temperature)

Sample Designation	CCL		Sample Identification		85N		
Test Date	2018-02-09		Ambient		24°C, 49%RH		
Sample No.	Span	Thickness	Width	Load	Flexural Strength $S=3PL/2bd^2$	Average	Requirement
	L	d	b	P			
	(mm)	(mm)	(mm)	(N)			
17930-75-9	25.40	1.069	25.26	286.622	378	378	≥311
17930-75-10		1.068	25.16	284.029	377		
17930-75-11		1.063	25.56	286.951	379		
17930-75-12		1.067	25.37	287.378	379		



Arc Resistance

SPECIMENS

Three specimens shall be 76mm×50mm. Material under 1.5mm in thickness shall be built up to provide a specimen at least 1.5mm, but not exceeding 3.2mm.

REFERENCE

IPC-4101E Specification for Base Materials for Rigid and Multilayer Printed Boards
IPC-TM-650 Method 2.5.1 Arc Resistance of Printed Wiring Material

METHOD/ REQUIREMENT

Unless otherwise specified the specimens shall be conditioned for 48^{+2}_{-0} hours in distilled water maintained at $50^{\circ}\text{C} \pm 2^{\circ}\text{C}$. Following this step the specimens shall be immersed in ambient temperature distilled water for 30 minutes minimum, 4 hours maximum, to allow them to reach temperature equilibrium without loss of moisture. The test shall be run at ambient temperature $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$ and ambient humidity. Remove a preconditioned specimen from the ambient temperature distilled water and wipe dry with a lint free paper towel. Place a specimen (individual or built up) in the electrode fixture. Operate the tester in accordance with the manufacturer's instructions such that an arc is generated and automatically switched as indicated below. Observe the arc carefully and, at the point which the arc disappears and tracking occurs, stop the timer and record the time for the specimen to the nearest second. Remove the specimen, remove and clean the electrodes thoroughly using a solvent and if necessary the crocus cloth. Replace the electrode and check the electrode gap.

RESULTS

The samples were tested by the methods given above. The test results meet the requirement of IPC-4101E/41 standards. See attached test data sheet for actually test result.

**Table 18 Arc Resistance Thin**

Sample Designation	CCL	Sample Identification	85N	
Test Date	2018-02-07~2018-02-09	Ambient	20°C, 50%RH	
Sample No.	Thickness	Times	Average	Requirement
	(mm)	(s)	(s)	(s)
17930-121-1	0.205	181	181	≥120
17930-121-2	0.205	181		
17930-121-3	0.208	182		

Table 19 Arc Resistance Thick

Sample Designation	CCL	Sample Identification	85N	
Test Date	2018-02-07~2018-02-09	Ambient	20°C, 50%RH	
Sample No.	Thickness	Times	Average	Requirement
	(mm)	(s)	(s)	(s)
17930-32-1	1.017	183	182	≥120
17930-33-1	1.029	182		
17930-34-1	1.036	181		



Thermal Stress

TEST SPECIMENS

Specimens shall be (50.8 ± 0.75) mm \times (50.8 ± 0.75) mm by the thickness of the laminate. Metallic clad laminate shall include specimens which are completely clad and fully etched.

REFERENCE

IPC-4101E Specification for Base Materials for Rigid and Multilayer Printed Boards

IPC-TM-650 Method 2.4.13.1 Thermal Stress of Laminates

METHOD/ REQUIREMENT

Place the sample in a $125^{\circ}\text{C} \pm 2^{\circ}\text{C}$ aircirculation oven for (4~6) h then take samples out from oven in to a dryer and cool to ambient temperature. Take sample into a 288°C solder bath to perform a solder float for 10s within 10min. This is for check whether there is any blistering, delamination or other damage.

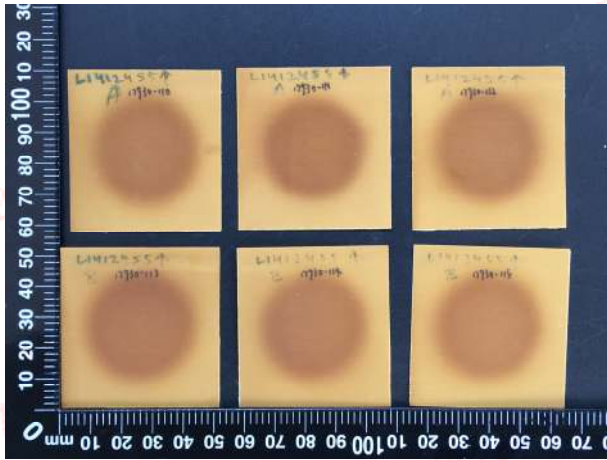
RESULTS

The samples were tested by the methods given above. The test results meet the requirements of IPC-4101E/41 standards. See attached test data sheets for actually test result.

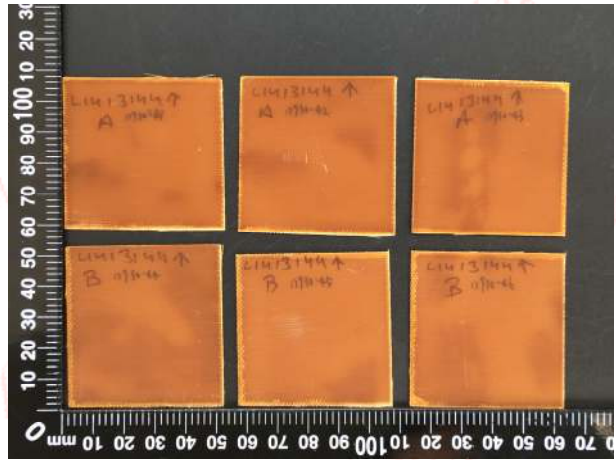


Table19 Thermal Stress

Sample Designation	CCL		Sample Identification	85N
Test Date	2018-02-09		Ambient	22°C, 49%RH
Sample No.			Test result	
17930-110	Etched	A surface	Thin	No obvious blister, delamination and other damage
17930-111				No obvious blister, delamination and other damage
17930-112				No obvious blister, delamination and other damage
17930-113				No obvious blister, delamination and other damage
17930-114				No obvious blister, delamination and other damage
17930-115				No obvious blister, delamination and other damage
17930-41		A surface	Thick	No obvious blister, delamination and other damage
17930-42				No obvious blister, delamination and other damage
17930-43				No obvious blister, delamination and other damage
17930-44				No obvious blister, delamination and other damage
17930-45				No obvious blister, delamination and other damage
17930-46				No obvious blister, delamination and other damage
17930-104	Unetched	A surface	Thin	No obvious blister, delamination and other damage
17930-105				No obvious blister, delamination and other damage
17930-106				No obvious blister, delamination and other damage
17930-107				No obvious blister, delamination and other damage
17930-108				No obvious blister, delamination and other damage
17930-109				No obvious blister, delamination and other damage
17930-35		A surface	Thick	No obvious blister, delamination and other damage
17930-36				No obvious blister, delamination and other damage
17930-37				No obvious blister, delamination and other damage
17930-38				No obvious blister, delamination and other damage
17930-39				No obvious blister, delamination and other damage
17930-40				No obvious blister, delamination and other damage



Picture 1 17930-110~17930-115 Thin



Picture 2 17930-41~17930-46 Thick

After the test (Etched)



Picture 3 17930-104~17930-109 Thin



Picture 4 17930-35~17930-40 Thick

After the test (Unetched)

No obvious blister, delamination and other damage



Electric Strength

SPECIMENS

Three specimens should be (100 ±25) mm× (100 ±25) mm.

REFERENCE

IPC-4101E Specification for Base Materials for Rigid and Multilayer Printed Boards
IPC-TM-650 Method 2.5.6.2 Electric Strength

METHOD/ REQUIREMENT

Unless otherwise specified, the specimen shall be conditioned for 48⁺²₀ hours in distilled water maintained at 50°C ± 2°C. Following this the specimen shall be immersed in the ambient temperature distilled water for 30 minutes minimum, 4 hours maximum, to achieve temperature equilibrium without significant changes in moisture content.

The test should be performed at ambient temperature, 23°C ± 5°C. Remove a preconditioned specimen from the ambient temperature water and wipe dry with a lint free paper towel. The leakage current is 5mA. Operate the tester such that the voltage is applied with 500 volts per second increase and observes the point at which the tester indicates a breakdown.

RESULTS

The samples were tested by the methods given above. The test results meet the requirement of IPC-4101E/41 standards. See attached test data sheet for actually test result.

Table 20 Electric Strength

Sample Designation	CCL	Sample Identification	85N
Test Date	2018-02-07~2018-02-09	Ambient	20°C, 50%RH
Sample No.	Average Thickness (mm)	Voltage (kV)	Electric Strength (kV/mm)
17930-122	0.221	11.68	52.85
17930-123	0.213	12.57	59.01
17930-124	0.221	11.61	52.53
Average			55
Requirement			≥30



Horizontal Burning Test

TEST SPECIMEN

Bar specimens measuring (125 ± 5) mm long by (13.0 ± 0.5) mm wide with the edges sanded smooth and the corners having a radius not exceeding 1.3 mm

REFERENCE

IPC-4101E Specification for Base Materials for Rigid and Multilayer Printed Boards
UL94, Section 8 Horizontal Burning Test; HB

METHOD/ REQUIREMENT

Sets of three bar test specimens shall be conditioned for a minimum of 48 h at (23 ± 2) °C and $50\% \pm 5\%$ relative humidity. Once removed from the conditioning chamber, the test specimens shall be tested within 1 h.

Six samples bars are to be tested in the following way (Three of them are backups). Mark the bar sample at the places $25\text{mm} \pm 1\text{mm}$ and $100\text{mm} \pm 1\text{mm}$ away from one end and clamp the other end tightly while inclining it for $45^\circ \pm 2^\circ$. Light the combustion lamp; adjust it to produce the blue $20\text{mm} \pm 2\text{mm}$ flames. Tilt the combustion lamp about 45° against the level ground towards the bar sample. Apply the flames from the lowest edge of the bar sample until the flames reach to the 6mm depth of the free end of the bar sample. Burn the bar sample for $30\text{s} \pm 1\text{s}$ without changing the position of the flames. If the flames reach the 25mm far from the free end in less than 30 seconds, move away the flames immediately. Initiate the timer when the flames reach the 25mm and keep record of the time needed before the flames just reach 100mm. if the flames fail to make it to the 100mm, keep record of the burning time (t) and the length (L) from the 25mm mark to the place where the burning stops.

Calculate the linear burning rate, V, in millimeters per minute, for each specimen using the equation:

$$V = \frac{60L}{t}$$

In Which:

V is the linear burning rate in mm/minute;

L is the damaged length, in millimeters;

t is time, in seconds

A material classed HB shall:

- Not have a burning rate exceeding 40 mm per minute over a 75mm span for specimens having a thickness of 3.0 to 13mm;
- Not have a burning rate exceeding 75mm per minute over a 75mm span for specimens having a thickness less than 3.0mm;
- Cease to before the 100mm reference mark

**RESULTS**

The samples were tested by the methods given above. The flammability classification is HB, the test results meet the requirement of IPC-4101E/41 standards. See attached test data sheet for actually test result.

Table 21 Horizontal Burning Test Thin

Sample Designation	CCL		Sample Identification	85N		
Test Date	2018-02-07~2018-02-11		Ambient	20°C, 50%RH		
Sample No.	Sample Thk	Flame time Te	Burning time Tb	Combustion length L	Burning rate v	Note
	(mm)	(s)	(s)	(mm)	(mm/min)	
17930-121-1	0.213	30	0	0	/	1
17930-121-2	0.209	30	0	0	/	1
17930-121-3	0.207	30	0	0	/	1
Avg:	0.210	Flammability classification				HB
Requirement						HB
Note:	1.The test specimen did not burn more than 25mm mark line.					
	2.The sample was burned more than 25mm mark line, and no more than 100mm mark line.					
	3.Sample burning more than 100mm mark line.					
	4.Samples have any burning particles drop.					

Table 22 Horizontal Burning Test Thick

Sample Designation	CCL		Sample Identification	85N		
Test Date	2018-02-07~2018-02-11		Ambient	20°C, 50%RH		
Sample No.	Sample Thk	Flame time Te	Burning time Tb	Combustion length L	Burning rate v	Note
	(mm)	(s)	(s)	(mm)	(mm/min)	
17930-47	1.061	30	0	0	/	1
17930-48	1.052	30	0	0	/	1
17930-49	1.067	30	0	0	/	1
Avg:	1.060	Flammability classification				HB
Requirement						HB
Note:	1.The test specimen did not burn more than 25mm mark line.					
	2.The sample was burned more than 25mm mark line, and no more than 100mm mark line.					
	3.Sample burning more than 100mm mark line.					
	4.Samples have any burning particles drop.					



Glass Transition Temperature and Cure Factor by DSC

TEST SPECIMEN

CCL 1 pcs

REFERENCE

IPC-TM-650 Method 2.4.25 Glass Transition Temperature and Cure Factor by DSC
IPC-4101E Specification for Base Materials for Rigid and Multilayer Printed Boards

METHOD/ REQUIREMENT

Rout out a disk from the metal clad sample 6.25 mm in diameter. Sand any rough edges of the specimen. Precondition the sample in an air-circulating oven by baking for 2 h \pm 0.25 h, at 105°C \pm 2°C. Cool the sample to room temperature for at least one-half hour in desiccators maintained at less than 30% RH before testing.

Mount the specimen in a standard aluminum sample pan with an aluminum lid. If the specimen is a powder, crimp the aluminum lid shut. For referee purposes, prepare a suitable reference by adding an equivalent weight of aluminum lids to the reference pan to match the weight of the specimen. Run the scan from 25°C at a rate of 20°C per minute. When the transition has been observed, scan at least 30°C beyond the transition region. If the cure factor is applicable and required, perform the following steps: Continue the scan to 250°C. Hold the specimen at the isothermal temperature for 15 min. Immediately cool the specimen to the initial conditions and run a second scan with the same parameters as the first scan. Determine the Tg and the delta Tg as required.

RESULTS

The samples were tested as given by the methods above. See attached test data sheet and test picture for actually test result.

Table 23 Glass Transition Temperature And Cure Factor by DSC			
Sample Designation	/	Sample Identification	/
Test Date	/	Ambient	/
Sample No.	/		
Element	Measurement (°C)	Requirement	
Tg1	No Requirement for IPC-4101E/41		
Tg2			
Cure Factor Δ Tg			



Decomposition Temperature (T_d)

TEST SPECIMEN

The specimen may be an unclad laminate material or laminate material with copper completely removed and that has been cut approximately square to fit into the TGA sample pan. Typical sample mass is 10 mg to 30 mg.

REFERENCE

IPC-TM-650 method 2.4.24.6 Decomposition Temperature (T_d) of Laminate Material Using TGA

IPC-4101E Specification for Base Materials for Rigid and Multilayer Printed Boards

METHOD/ REQUIREMENT

The test samples should be baked at $110^{\circ}\text{C}\pm 2^{\circ}\text{C}$ for 24 h and placed in a desiccator for cooling to room temperature prior to testing. In standard lab conditions, the TGA test should be started within 15 minutes of removing test sample from the desiccator. Place the sample in the TGA and measure its mass. Heat the sample at a rate of $10^{\circ}\text{C}/\text{min}$ from ambient (not to exceed 50°C) to 550°C . Report the temperature at which the mass of the sample is 2% less than its mass measured at 50°C (T_d 2%) and the temperature at which the mass of the sample is 5% less than its mass measured at 50°C (T_d 5%).

RESULTS

The samples were tested by the methods given above. See attached test data sheet and test pictures for actually test result.

Table 24 Decomposition Temperature Test

Sample Designation:	/	Sample Identification	/
Test Date:	/	Ambient:	/
Sample No.	Decomposition temperature ($^{\circ}\text{C}$)		
	mass loss at 2%	mass loss at 5%	
/	No Requirement for IPC-4101E/41		
Requirement			



Glass Transition Temperature (TMA)

TEST SPECIMEN

Two specimens shall be approximately 6.35 mm×6.35 mm by the thickness of the sample.

REFERENCE

IPC-TM-650 Method 2.4.24 Glass Transition Temperature and Z-Axis Thermal Expansion by TMA

IPC-4101E Specification for Base Materials for Rigid and Multilayer Printed Boards

METHOD/ REQUIREMENT

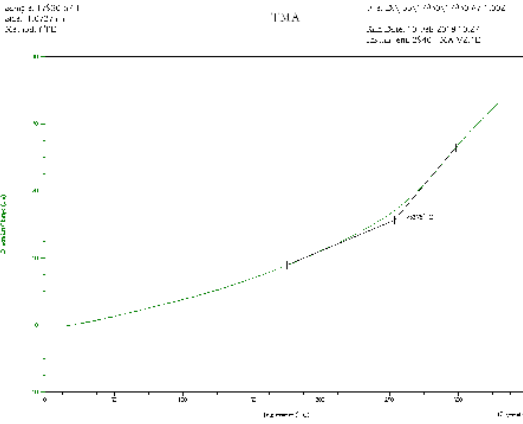
Two specimens were prepared by cutting out approximately 6.35 mm×6.35 mm and sanding any rough edges. The specimens were preconditioned by baking for 2 h±0.25 h, at 105°C ±2°C, then cooled to room temperature in a desiccators. Measure and record the thickness of the specimens. Mount the specimen on the stage of the TMA and apply a load 5 g. Start the scan at a temperature no higher than 35°C to 330°C, at a rate of 10°C/min. The glass transition temperature shall be calculated over the specified regions.

RESULTS

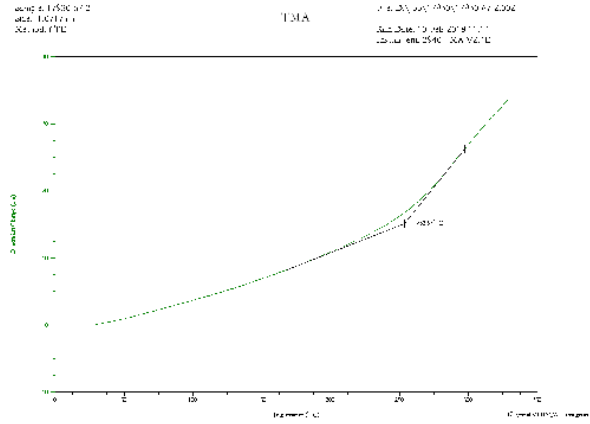
The samples were tested as given by the methods above. The test results meet the requirement of IPC-4101E/41 standards. See attached test data sheet and test picture for actually test result.

Table 25 Glass Transition Temperature (TMA)

Sample Designation	CCL	Sample Identification	85N
Test Date	2018-02-06~2018-02-10	Ambient	22°C, 47%RH
Sample No.		Tg(°C)	
17930-67-1		253.75	
17930-67-2		253.67	
Requirement		≥250	



Picture 5 17930-67-1 85N



Picture 6 17930-67-2 85N



Time to Delamination

TEST SPECIMEN

Two specimens shall be approximately 6.35mm × 6.35mm by the thickness of the sample.

REFERENCE

IPC-TM-650 Method 2.4.24.1 Time to Delamination (TMA Method)

IPC-4101E Specification for Base Materials for Rigid and Multilayer Printed Boards

Customer Technical Requirement

METHOD/ REQUIREMENT

Two specimens were prepared by cutting out approximately 6.35mm × 6.35mm and sanding any rough edges. The specimens were preconditioned by baking for 2h±0.25h, at 105°C ±2°C, then cooled to room temperature in a desiccators. Measure and record the thickness of the specimens. Mount the specimen on the stage of the TMA and apply a load 5g. Start the scan at a temperature no higher than 35°C to 260°C, 288°C and 300°C at a rate of 10°C per minute, hold at that temperature until failure. The time to delamination is determined as the time from the onset of the isotherm to failure.

RESULTS

The samples were tested as given by the methods above. See attached test data sheet and test picture for actually test result.

Table 26 Time to Delamination

Sample Designation	/	Sample Identification	/	
Test Date	/	Ambient	/	
Sample No.	Test Item	Time of Reversible Event (min)	Time of Delaminate (min)	Requirement
/	T260	No Requirement for IPC-4101E/41		
/				
/	T288			
/				
/	T300			
/				



Dimensional Stability

TEST SPECIMENS

Three specimens shall be 300mm×280mm in size with the warp direction in the 300mm dimension.

REFERENCES

IPC-TM-650 Method 2.4.39 Dimensional Stability, Glass Reinforced Thin Laminates
IPC-4101E Specification for Base Materials for Rigid and Multilayer Printed Boards

METHOD/ REQUIREMENT

Mark the specimen for traceability in the identification area. Prepare the four location points by drilling or scribing. Measure distances F_1 , F_2 , W_1 , and W_2 .

Bake Process: Etching the sample, bake specimens at $105^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for $4\text{h} \pm 5\text{min}$. After baking, immediately place the test specimens in a stabilization chamber.

Remove from stabilization chamber after $1^{+0.5}_{-0}\text{h}$ and within 5min, measure F_{11} , F_{21} , W_{11} , and W_{21} .

Thermal Stress Process: Bake specimens at $150^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for $2\text{h} \pm 5\text{min}$. After baking, immediately place the test specimens in a stabilization chamber.

Remove from stabilization chamber after $1^{+0.5}_{-0}\text{h}$ and within 5min, measure F_{12} , F_{22} , W_{12} , and W_{22} . Use the below formula to calculate result:

After Bake Process:

$$\text{MD} = (W_{x1} - W_x) \times 10^6 / W_x \text{ (ppm)} \quad (x=1,2)$$

$$\text{TD} = (F_{x1} - F_x) \times 10^6 / F_x \text{ (ppm)} \quad (x=1,2)$$

After Thermal Stress Process:

$$\text{MD} = (W_{x2} - W_x) \times 10^6 / W_x \text{ (ppm)} \quad (x=1,2)$$

$$\text{TD} = (F_{x2} - F_x) \times 10^6 / F_x \text{ (ppm)} \quad (x=1,2)$$

W_1, W_2, F_1, F_2 = initial dimensions

$W_{11}, W_{21}, F_{11}, F_{21}$ = after bake dimensions

$W_{12}, W_{22}, F_{12}, F_{22}$ = after thermal stress dimensions

RESULTS

The samples were tested by the methods given above, the test results meet the requirement of IPC-4101E. See attached test data sheet for actual test result.



Table 27 Dimensional Stability Thin

Sample Designation	CCL		Sample Identification	85N				
Test Date	2018-02-24~2018-02-26		Ambient	(22~24)°C, (49~51)%RH				
Sample No.	After Bake Process (ppm)				After Thermal Stress Process (ppm)			
	MD		TD		MD		TD	
18012-6	-48	-197	-162	51	24	-173	75	102
18012-7	-93	101	-32	138	-169	52	-67	122
18012-8	-113	-113	-51	-75	-165	-101	142	-114
Requirement	-300~300							

Table 28 Dimensional Stability Thick

Sample Designation	CCL		Sample Identification	85N				
Test Date	2018-02-24~2018-02-26		Ambient	(22~24)°C, (49~51)%RH				
Sample No.	After Bake Process (ppm)				After Thermal Stress Process (ppm)			
	MD		TD		MD		TD	
18012-18	8	-52	24	142	-16	36	95	75
18012-19	60	-28	35	-8	-48	-44	-4	-28
18012-20	-117	-64	-51	-8	-149	-85	-32	-28
Requirement	-300~300							



Solderability (Edge Dip Test)

TEST SPECIMENS

The test specimen shall be a portion of the printed board not greater than 75 mm×75 mm, the suggested coupon, or the complete board if it is smaller than this size.

REFERENCE

IPC-4101E Specification for Base Materials for Rigid and Multilayer Printed Boards
IPC J-STD-003C; 4.2.1 Edge Dip Test
Customer Technical Requirement

METHOD/ REQUIREMENT

Edge Dip Test (Tin/lead solder): The samples are to be dipped in the flux to the full depth to be soldered for (5-10) seconds. After withdrawal from the flux, the test specimen shall be allowed to drain vertically for a maximum of 60 seconds. Excess flux shall be removed by blotting the surface to be tested with a piece of clean, absorbent material. The solderability test shall then be performed not less than one minute, and not more than five minutes, after blotting.

Wiped with isopropyl alcohol and immersed in a 20% by volume solution of hydrochloric acid, Baume that is maintained at $21^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for 15s. The specimens shall be rinsed with a cold water spray rinse for 5s and blown dry with filtered, oil free, compressed air.

The sample should be dip on tin/lead solder bath be maintained at $(235 \pm 5)^{\circ}\text{C}$ edgewise to a depth of (25 ± 2) mm. The dwell time in the molten solder is 10s. Immersion time may have to be adjusted depending on the construction of the board. A dwell time of up to 30 seconds maybe required for heavy or high copper content boards. After withdrawal, the solder shall be allowed to solidify by air cooling while the board is maintained in a vertical position. Specimens shall have the flux removed after the test, than examination the tested area.

A minimum of 95% of each of surfaces being tested shall be exhibit good wetting. The balance of the surface may contain only small pin holes, dewetted areas, and rough spots provided such defects are not concentrated in one area. There shall be no nonwetting or exposed base metal within the evaluated area.

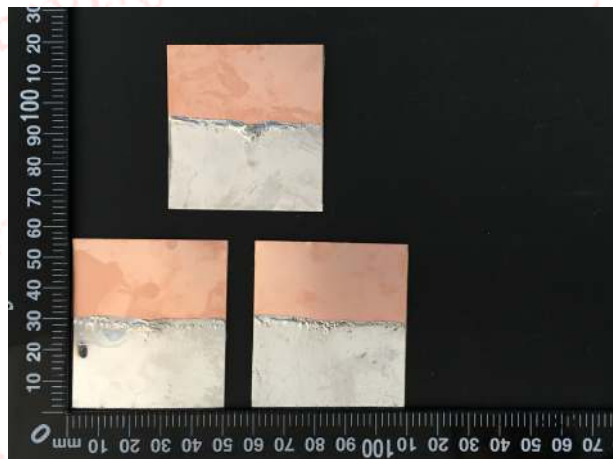
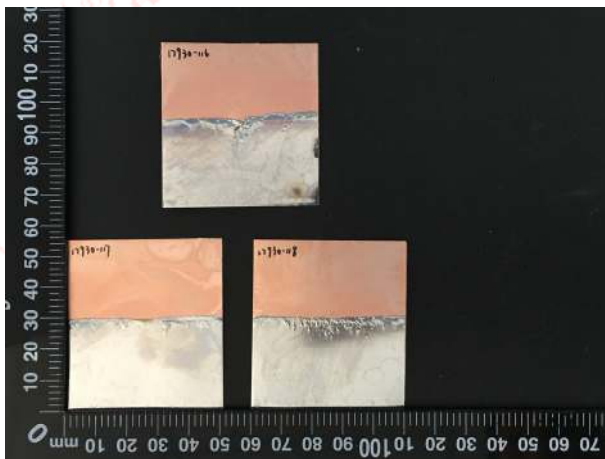
RESULTS

The samples were tested by the methods given above. The test results meet the requirements of IPC-4101E standards. See attached test data sheets for actually test result.

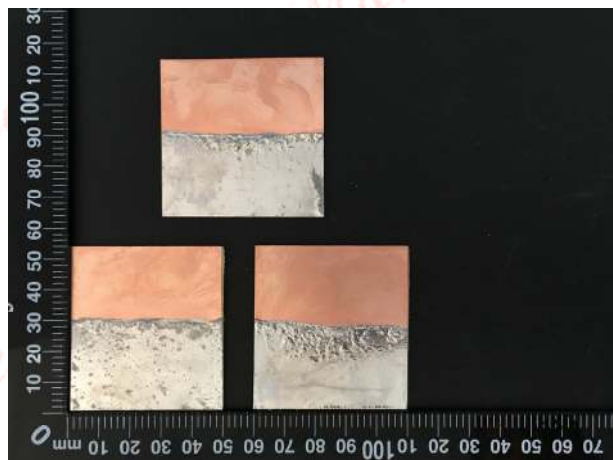
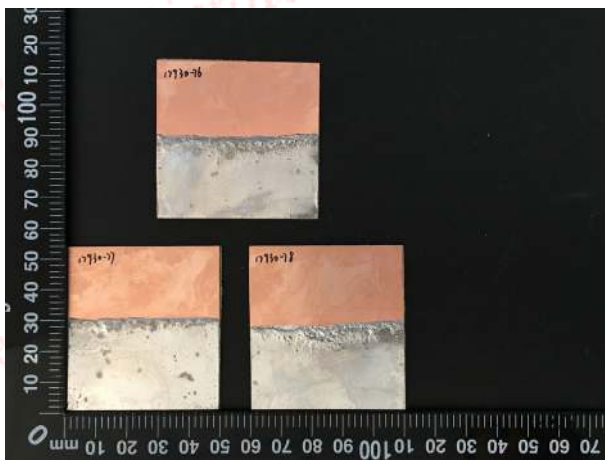


Table 29 Solderability (Edge Dip Test)

Sample Designation	CCL	Test Date	2018-02-08
Sample Quantity	6 pcs	Ambient	21°C, 48%RH
Sample No.	Sample Identification	Test result	
17930-116	85N (Thin)	Sample surface exhibits good wetting	
17930-117		Sample surface exhibits good wetting	
17930-118		Sample surface exhibits good wetting	
17930-76	85N (Thick)	Sample surface exhibits good wetting	
17930-77		Sample surface exhibits good wetting	
17930-78		Sample surface exhibits good wetting	



Picture 7 17930-116~17930-118 Thin Top 17930-116~17930-118 Thin Bottom
After the test Defects: None found



Picture 8 17930-76~17930-78 Thick Top 17930-76~17930-78 Thick Bottom
After the test Defects: None found



Metal Surface Cleanability

TEST SPECIMEN

The specimens shall be (50.8 ± 0.5) mm \times (50.8 ± 0.5) mm by the thickness of the material. Edges shall be smooth.

REFERENCE

IPC-TM-650 Method 2.3.1.1 Chemical Cleaning of Metal-Clad Laminate

IPC-4101E Specification for Base Materials for Rigid and Multilayer Printed Boards

METHOD/ REQUIREMENT

Place the specimen in a cleaner/degreaser solution and gently agitate for (30 ± 5) seconds. Remove the specimen and flush with tap water. Next place the specimen in a 180 g/L sodium persulfate micro etch solution with $(38 \pm 3)^{\circ}\text{C}$ for (30 ± 5) seconds and vigorously agitate. Remove the specimen and flush with deionized water for (1~2) minutes.

RESULTS

The samples were tested by the methods given above. See attached test data sheet for actually test result.

Table 30 Metal Surface Cleanability

Sample Designation	CCL	Sample Identification	85N
Test Date	2018-02-08	Ambient	19°C, 50%RH
Sample No.	Test Result		
17930-79	A uniform matte finish formed on the metal cladding of the test specimen. No bead or puddles formed on the metal surface after pouring deionized water on it		
17930-80	A uniform matte finish formed on the metal cladding of the test specimen. No bead or puddles formed on the metal surface after pouring deionized water on it		
17930-81	A uniform matte finish formed on the metal cladding of the test specimen. No bead or puddles formed on the metal surface after pouring deionized water on it		
Requirements	The metal cladding on the test specimen shall be cleaned to a uniform matte finish. Deionized or distilled water poured on the metal surface does not bead or form puddles.		



Pressure Cooker Test

TEST SPECIMEN

5 pcs specimens, the dimension is 100mm×100mm.

REFERENCE

IPC-4101E Specification for Base Materials for Rigid and Multilayer Printed Boards
IPC-TM 650 2.6.16 Pressure Vessel Method for Glass Epoxy Laminate Integrity

METHOD/ REQUIREMENT

Maintain the samples at 15 psi for 30⁺²₋₀ minutes in pressure cooker.

Carefully remove the hot specimens from the pressure vessel and blot dry with paper towel.

The specimens shall be maintained at ambient temperature, and within 10 minutes it shall be immersed vertically into the solder bath which is maintained at either 500⁺¹⁰₋₀°F

(260⁺⁵₋₀°C) for 20s

Visual inspection samples after the test. Check if there is any measles, blisters, delamination, convolution or surface erosion.

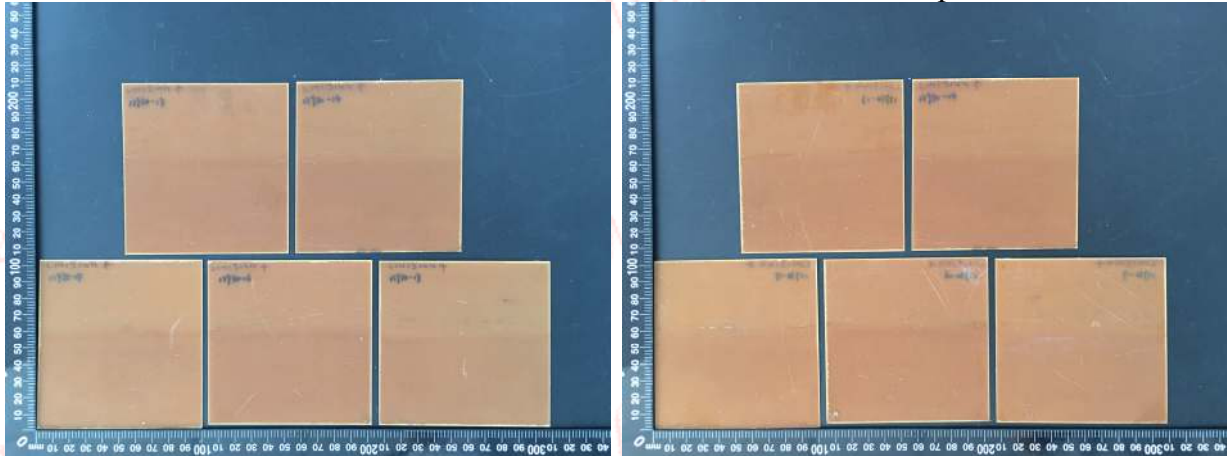
Value	Condition
5	The samples have no measles, blisters, or surface erosion.
4	Occasional minute (1/32 inch or less) measles.
3	Minute measles scattered across the specimen.
2	Occasional minor blisters (two to four adjacent weave intersections).
1	Large blisters, delamination, or convolution.

RESULTS

The samples were tested by the methods given above. See attached test data and test picture sheet for actually test result.

Table 31 Pressure Cooker Test

Sample Designation	CCL	Sample Identification	85N
Test Date	2018-02-08	Ambient	21°C, 48%RH
Sample No.	Test result		
17930-13	Grade 5:The sample have no measles, blisters, or surface erosion.		
17930-14	Grade 5:The sample have no measles, blisters, or surface erosion.		
17930-15	Grade 5:The sample have no measles, blisters, or surface erosion.		
17930-16	Grade 5:The sample have no measles, blisters, or surface erosion.		
17930-17	Grade 5:The sample have no measles, blisters, or surface erosion.		



Picture 9 After the test Top

Picture 10 After the test Bottom

17930-13~17930-17 85N

The samples have no measles, blisters, or surface erosion.



Report Number: 17931EG

CERTIFICATE OF CONFORMANCE

Microtek (Changzhou) Laboratories certifies that the test equipment used complies with the calibration requirements of correlation criterion and that the data contained in this report is accurate within the tolerance limitation of this equipment.

The report is invalid without signature of approver and "Special seal for test report", and the test results of this report are only responsible for tested samples.

The report shall not be reproduced, except in full, without the written approval of Microtek (Changzhou) Laboratories.

Thank you for selecting Microtek (Changzhou) Laboratories for your testing requirements.

Edited by:

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Project Engineer
Date: 2018-03-05

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Marry Yang
Project Manager
Date: 2018-03-05

Approved by:

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Gestar
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