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First edition
2007-05

**Materials for printed boards and other
interconnecting structures –**

**Part 3-1:
Copper-clad laminates for flexible boards
(adhesive and non-adhesive types)**



JPCA

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

MATERIALS FOR PRINTED BOARDS AND OTHER INTERCONNECTING STRUCTURES –

Part 3-1: Copper-clad laminates for flexible boards (Adhesive and non-adhesive types)

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Following publication of this PAS, which is a pre-standard publication, the technical committee or subcommittee concerned will transform it into an International Standard.

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MATERIALS FOR PRINTED BOARDS AND OTHER INTERCONNECTING STRUCTURES –

Part 3-1: Copper-clad laminates for flexible boards (Adhesive and non-adhesive types)

1 Scope

This PAS specifies the properties of copper-clad laminates used for flexible boards for both adhesive and non-adhesive types.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

JPCA-TD01, *Terms and definition for printed circuits*

JIS C 5603, *Terms and definition for printed circuits*

JIS C 6471, *Test methods of copper-clad laminates for flexible printed wiring boards*

JIS C 6472, *Copper-clad laminates for flexible printed wiring boards (Polymer film, Polyimide film)*

JIS C 6515, *Copper foil for printed wiring boards*

IEC 60194, *Printed board design, manufacture and assembly – Terms and definitions*

IPC-4204, *Flexible Metal-Clad Dielectrics for Use in Fabrication of Flexible Printed Circuitry*

ASTM D149, *Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies*

ASTM D150, *Standard Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation*

ASTM D882, *Standard Test Method for Tensile Properties of Thin Plastic Sheeting*

3 Terms and definitions

For the purposes of this document, the following terms and definitions, as well as those mentioned in IEC 60194, JIS C 5603 and JPCA-TD01, apply.

3.1

machine direction (MD)

longitudinal direction in production of film, copper foil, and copper-clad laminate

3.2

transverse direction (TD)

transverse direction in production of film, copper foil, and copper-clad laminate

4 Designation of copper-clad laminates

The designation of types of laminates shall be made in the following way. Constituent designations are connected by hyphens.

Symbol for identifying copper-clad laminate	Symbol for base material and its thickness	Symbol for adhesive and its thickness	Symbol for type and grade of copper-foil and thickness	Symbol for profile and treatment	Symbol for flammability
(3.1)	(3.2) (3.3)	(3.4) (3.5)	(3.6) (3.7) (3.8)	(3.9) (3.10)	(3.11)
Example: ADF	- E6	- TA	- E1/12/12	- V1	- F

4.1 Copper-clad laminate

The symbol to show the types of flexible printed wiring boards (hereinafter called CCL) shall be as given in Table 1.

Table 1 – Copper-clad laminates

Symbol	Copper-clad laminate
ADF	Adhesive type (3-layer) CCL
ALF	Non-adhesive type (2-layer) CCL

4.2 Base materials

The symbol to designate the base material shall be as given in Table 2.

Table 2 – Base materials

Symbol	Base material
E	Polyimide
B	Polyethylene terephthalate (PET)
A	Polyvinyl fluoride (PVF)
C	Ethylene fluoride-propylene copolymer (FEP)
D	Polytetra fluoroethylene (PTFE)
F	Aramid
G	Polyamide-imide
H	Epoxy
J	Polyether imide
K	Polysulfone
L	Polyethylene naphthalate (PEN)
M	Liquid crystal polymer (LCP)
X	Others

4.3 Thickness of the base material

The symbol to designate the thickness of base material shall be as given in Table 3.

Table 3 – Thickness of base material

Symbol	Thickness of base material μm
0	No base material
1	25
2	50
3	75
4	100
5	125
6	12,5
7	38
8	17,5
9	10
10	7,5
11	20
12	40
X	Other thickness
NOTE A thickness of 15 μm is an example of another thickness.	

4.4 Types of adhesives

The symbol to designate the adhesive shall be as given in Table 4.

Table 4 – Adhesives

Symbol	Adhesive
L	Epoxy resin
M	Acrylate
N	Polyester
O	No adhesive
P	Butyl phenol
R	Ethylene fluoride–propylene copolymer (FEP)
S	Nitrile phenol
T	Polyimide
U	Polyether
W	Perfluoroalkoxy (PFA)
Y	Cyanate ester
X	Other thickness

4.5 Thickness of base materials and adhesives

The symbol to designate the thickness of base material and adhesives shall be as given in Table 5.

Table 5 – Thickness of adhesives

Symbol	Thickness of adhesive μm
O	No adhesive
A	2,5
B	5
C	7,5
D	10
E	13
F	15
H	18
J	20
K	23
L	40
M	25
X	Other thickness

4.6 Type of copper foil

The symbol to designate the type of copper foil shall be as follows.

- Type E: Electrodeposited copper foil
 Type R: Rolled copper foil
 Type O: Other type

4.7 Grade of copper foil

The symbol to designate the grade of copper foil shall be as given in Table 6. A slash shall be used between the symbols of grade and the thickness of the copper foil.

Table 6 – Grade of copper foil

Symbol	Type of copper foil
E1	Standard electrodeposited copper foil
E2	High-ductility electrodeposited copper foil
E3	High temperature elongation electrodeposited copper foil
R1	As-rolled wrought copper foil
R2	Light cold-rolled wrought copper foil
R3	Annealed wrought copper foil
O	Copper foil made by means other than rolling or electrolysis

4.8 Copper-foil thickness

The symbol to designate the thickness of copper foil shall be as given in Table 7. The thicknesses of the copper foils on both surfaces of a base (double-sided laminate) are expressed by two numbers separated by a slash. The thickness of copper foil of single-sided laminate is expressed with "0" after the slash. In the case of double-sided CCL with different copper foil thickness on both sides of the laminate, the thicker copper foil thickness shall be stated first in front of the slash. The designation for type O is to be agreed upon between the supplier and the user.

Table 7 – Thickness of copper foil (Types E and R)

Symbol	Nominal thickness μm	Mass designation g/m^2
Less than 5	Less than 5	To be agreed upon between the supplier and the user
9	9	76
12	12	107
18	18	152
25	25	230
35	35	305
50	50	445
70	70	610

4.9 Types of profiles

The symbol to designate the profile of copper foil to increase the adhesivity of the copper surface shall be as given in Table 8.

Table 8 – Types of profiles

Designation	Type	Ten-point height of roughness profile (Rz) μm
S	Standard	Less than 14*
L	Flatter than S (low profile)	Less than 10
V	Flatter than L (very low profile)	Less than 5
Z	Flatter than Z (ultra low profile)	Less than 2,5
* Applicable range: Thickness of less than 70 μm		
NOTE The measurement of the surface roughness is made by a stylus instrument. Use of an optical laser surface measurement is based on agreement between the user and the supplier.		

4.10 Surface treatment to increase copper adhesivity and anti-rust

The surface treatment for the purpose of increasing copper adhesivity and for anti-rusting may be applied on either both sides or a single side of the CCL. The symbol for the surface treatment shall be as follows.

0. No surface treatment for adhesivity increase, but both surfaces treated for anti-rusting.
1. Surface treatment for adhesivity increase on one surface, and treated for anti-rusting on both sides.
2. Surface treatment for adhesivity increase on both surfaces, and also treated for anti-rusting on both sides.

4.11 Symbol for flammability

An English capital letter "F" shall be designated when CCL complies the requirement of flammability stated in 6.3 (properties of CCL).

5 Observation

5.1 Base film

There shall be no break, hole, or wrinkle by folding in base film. There shall not be any defect that is harmful for the performance of CCL such as scratch, dent, surface damage, or any contamination.

5.2 Copper foil

The surface appearance shall comply with JIS C 6515, Clause 9. The surface condition for type O shall be agreed upon between the user and the supplier.

5.3 CCL

The appearance of the CCL shall comply with Table 9.

Table 9 – Appearance of CCL

Appearance	General purpose		High-quality products	
Copper-foil surface	(1) No swell nor wrinkle			
	(2) Corrosion product, discoloration, or adhered foreign substance on the surface shall be easily removed using diluted chloric acid of 1 mol/dm ³ , or other appropriate solvent			
	(3) There shall be no harmful scratches that may affect the performance of CCL			
	(4) The number of pinholes with a diameter larger than 0,10 mm but smaller than 0,25 mm in the area specified in JIS C 6471, 6.1.2, shall be less than one. There shall be no pin hole with a diameter larger than 0,25 mm. The number of pinholes with a diameter smaller than 0,10 mm shall be agreed between user and supplier		(4) The number of pinholes with a diameter larger than 0,10 mm but smaller than 0,15 mm in the area specified in JIS C 6471, 6.1.2, shall be less than one. There shall be no pin hole with a diameter larger than 0,15mm. The number of pinholes with a diameter smaller than 0,10mm shall be agreed between user and supplier	
	(5) The dents in the area specified in JIS C 6471, 6.1.2, are evaluated by the total points for dents according to the following table. The total points for dents shall be no greater than 35. The dents smaller than 0,25 mm shall be agreed between user and supplier		(5) The dents in the area specified in JIS C 6471, 6.1.2, are evaluated by the total points for dents according to the following table. The total points for dents shall be no greater than 25. There shall be no dent with a diameter larger than 1,00 mm. The dents smaller than 0,10 mm shall be agreed between user and supplier	
	Maximum diameter of dent and points		Maximum diameter of dent and points	
	Maximum diameter of dent mm	Point	Maximum diameter of dent mm	Point
	0,25 ≤ <0,50	2	0,10 ≤ <0,25	1
0,50 ≤ <0,75	4	0,25 ≤ <0,50	2	
0,75 ≤ <1,00	7	0,50 ≤ <0,75	4	
1,00 ≤	30	0,75 ≤ <1,00	20	
Base film surface	The surface shall be flat, and there shall be no swell, crack, or foreign substance that affects the performance of the material, dirt, dust, colour non-uniformity, cut, unevenness, or striped pattern			
Copper foil removed surface	There shall be no harmful cut, void, colour non-uniformity, nor striped pattern. Copper particles, foreign substances, and dust shall easily be removed by diluted hydrochloric acid of 1 mol/dm ³ or other appropriate solvent			

6 Size

6.1 Base film

6.1.1 Thickness and its allowance

The thickness and its allowance of base film shall comply with Table 10.

Table 10 – Thickness and its allowance of base film

Nominal thickness μm	Allowance %
7,5	To be agreed between user and supplier
10	
12,5	
17,5	± 16
20	± 15
25	± 12
38	
40	
50	
75	± 10
100	
125	

6.2 Copper foil

6.2.1 Thickness and its allowance

The thickness and its allowance of copper foil shall comply with Table 11. The thickness and its allowance for copper foil of type shall be agreed between user and supplier.

Table 11 – Thickness and its allowance of copper foil (Types E and R)

Nominal thickness μm	Weight g/m^2	Specification	
		Allowance of thickness and weight %	
		Class I	Class II (for flexible boards)
Less than 5	To be agreed between user and supplier	To be agreed between user and supplier	To be agreed between user and supplier
9	76	± 10	± 5
12	107		
18	152		
25	230		± 10
35	305		
50	445		
70	610		

The measurement of copper foil with a thickness of less than 5 μm shall be made by the weight method (IPC-TM-650-2.2.12.2).

6.3 Adhesives

6.3.1 Adhesives

The thickness and its allowance of copper foil shall comply with Table 12.

Table 12 – Thickness and its allowance of adhesives

Thickness μm	Allowance %
<20	± 15
$20 \leq$	± 10

6.4 Copper-clad laminates

6.4.1 Thickness and its allowance

- The thickness of CCL with adhesive layer (three layers) shall be expressed by the sum of the thickness of the base film to be used, that of the copper foil, and that of the adhesive. The allowance for the thickness of CCL shall be within $\pm 20\%$ of the total thickness.
- The thickness of CCL without adhesive layer (two layers) shall be expressed by the sum of the thickness of the base film to be used, that of the copper foil, and that of the adhesive. The allowance for the thickness of CCL shall be within $\pm 20\%$ of the total thickness.

6.4.2 Sheet dimension and its allowance

The dimension of CCL in sheet form (length $\times$ width) shall be agreed upon between the user and the supplier.

6.4.3 Role dimension and its allowance

The dimension of CCL in role form (length $\times$ width) shall be agreed upon between the user and the supplier.

7 Properties

7.1 Base film

The properties of polyimide film shall be as specified in Table 13. The properties of other base film shall be agreed upon between the user and the supplier.

Table 13 – Properties of polyimide film

Item		Unit	Nominal thickness μm											Test method	
			7,5	10	12,5	17,5	20	25	38	40	50	75	100		125
Resistivity		Ωcm	To be agreed between user and supplier	10 ¹⁵ ≤											JIS C 2318 or ASTM D149
Breakdown voltage	Average	kV		2,5 ≤		4 ≤			5 ≤		7 ≤	9 ≤	11 ≤		JIS C 2318 or ASTM D149
	Minimum			—		—			2 ≤		3 ≤	4 ≤	5 ≤		
Permittivity	1MHz	—		≤ 4,0											IPC-TM-650 2.5.5.3 or ASTM D150
Loss tangent	1MHz	—		≤ 0,05											
Tensile strength		N/mm ²		137 ≤		146 ≤									JIS C 2318 or ASTM D882
Elongation		%		25 ≤											
Shrinkage by heating	200°C	%		≤ 0,30											IPC-TM-650 2.2.4 or ASTM D882
Flatness		—		To be agreed between user and supplier											IEC 674-2

7.2 Copper foil

Properties of copper foil shall be as specified in Tables 14 and 15. The properties of copper foil of type O shall be agreed upon between the user and the supplier.

Table 14 – Properties of copper foil (type E)

Item	Unit	Thickness Nominal μm	Specification						Test method JIS C 6515
			Room temperature 23 °C			High temperature 180 °C			
Purity	%		99,8 ≤						5. According to the test method (copper purity) for "untreated copper foil, type E"
Surface roughness	μm		≤ 0,43						Surface roughness shall be expressed by the averaged roughness at the centreline (Ra) in accordance with Annex A of this standard
Resistance (maximum)	mΩ	5 9 12 18 25 35 50 70	25,0 15,0 10,4 7,1 4,7 2,5 2,4 1,7						6. According to the test method (electrical) for electrical resistance for the maximum test specimen
Tensile strength (minimum)	N/mm ²		E1	E2	E3	E1	E2	E3	7. According to the test method for tensile strength
		5 9 12 18 25 35 50 70	— 105 105 105 150 210 210 210	— 105 105 105 150 210 210 210	— 105 105 105 150 210 210 210	— 		— 130 130 130 135 140 155 175	
Elongation (minimum)	%		E1	E2	E3	E1	E2	E3	7. According to the test method for tensile strength
		5 9 12 18 25 35 50 70	— 2 2 2 2,5 3 3 3	— 5 5 5 7,5 10 12,5 15	— 2 2 2 2,5 3 3 3	— 		— 2 2 2,5 3 3 3 3	
Resistivity to bending	Cycle	5 9 12 18 25 35 50 70	— 300 ≤ 100 ≤ 10 ≤						According to JIS P 8115 (MIT test method) Curvature radius: 2 mm Load: 500 g. 175 cycles/min Room temperature and after anneal of 1 h at 180 °C

Table 15 – Properties of copper foil (type R)

Item	Unit	Thickness Nominal μm	Specification			Test method JIS C 6515	
			Room temperature 23 °C		High temperature 180 °C		
Purity	%		99,9 ≤			5. According to the test method for (copper purity), “untreated copper foil, type E”	
Surface roughness	μm		≤ 0,25			Surface roughness shall be expressed by the averaged roughness at the centreline (Ra) in accordance with Annex A of this standard	
Resistance (maximum)	mΩ	5 9 12 18 25 35 50 70	22,5 13,4 9,6 6,7 4,5 3,4 2,3 1,7			6. According to the test method (electrical) for the electrical resistance for the maximum test specimen	
Tensile strength (minimum)	N/mm ²		R1	R2	R3	R1 R2 R3	7. According to the test method for tensile strength
		5	—	—	—	—	
		9	350	—	105	—	
		12	350	—	105	—	
		18	350	—	105	—	
		25	350	—	120	—	
		35	350	180	140	—	
		50	350	180	155	—	
Elongation (minimum)	%		R1	R2	R3	R1 R2 R3	7. According to the test method for tensile strength
		5	—	—	—	—	
		9	0,5	—	5	—	
		12	0,5	—	5	—	
		18	0,5	—	5	—	
		25	0,5	—	7,5	—	
		35	0,5	10	10	—	
		50	0,5	12,5	15	—	
Resistivity to bending	Cycle	5	—			According to JIS P 8115 (MIT test method) Curvature radius: 2 mm, Load: 500g , 175 cycles/min Room temperature and after anneal of 1 h at 180 °C	
		9	600 ≤				
		12					
		18					
		25	200 ≤				
		35					
		50	20 ≤				
		70					

7.3 CCL

The properties of CCL shall be as specified in Tables 16 and 17. The properties of other CCL including high Tg and halogen-free materials shall be agreed upon between the user and the supplier.

**Table 16 – Properties of CCL –
Adhesive type (three layers)/polyimide film base**

Item			Unit	Specification		Test method JIS C 6471
Observation			—	According to Table 9		According to 6.1 (observation)
Size	Thickness		—	According to 5.4.1		According to 6.2.1 (thickness)
	Width			According to 5.4.2 and 5.4.3		According to 6.2.2 (width)
	Length					According to 6.2.3 (length)
Resistivity	Normal		$\Omega \cdot \text{cm}$	$10^{13} \leq$		According to 7.1 (resistivity)
	After water vapour adsorption			$10^{12} \leq$		
Surface resistivity	Normal		Ω	$10^{11} \leq$		According to 7.2 (surface resistivity)
	After water vapour adsorption			$10^{10} \leq$		
Surface withstanding voltage AC 500 V, 1 min			—	There shall be no flash-over		According to 7.3 (surface withstanding voltage)
Interlayer withstanding voltage AC 500 V, 1 min			—	There shall be no breakdown		According to 7.4 (interlayer withstanding voltage)
Dielectric constant (1 MHz)			—	$\leq 4,0$		According to 7.5 (dielectric constant and loss tangent)
Loss tangent (1 MHz)			—	$\leq 0,07$		
Peel strength of copper foil (Thickness of polyimide film: 25 μm)	Thickness of copper foil		—	$8 \leq < 35$	$35 \leq$	According to 8.1 (peel strength of copper foil) (when the thickness of the copper foil is less than 8 μm , electroplate copper on the foil as to attain the thickness of more than 8 μm)
	Item	Normal	N/mm	$0,7 \leq$	$0,8 \leq$	
		After heating		$0,6 \leq$		
		Dipped into solder		—	—	
		Dipped into chemicals		$0,5 \leq$	$0,6 \leq$	
Bending (Bending radius is $R = 2,0 \text{ mm}$ for thickness of polyimide film: 25 μm)	Copper foil	Type R	Cycle	18	$300 \leq$	According to 8.2 (bending)
				35	$250 \leq$	
				18	$500 \leq$	
				35	$400 \leq$	

Table 16 – Properties of CCL (continued)

Item			Unit	Specification	Test method JIS C 6471	
Flammability			—	Specimen shall satisfy the following specification	According to 9.1 (flammability)	
				Item		Specification
				(1) Flaming time		Within 10 s for each time, and total of less than 50 s for 10 trials
				(2) Flaming and glowing times		Less than 30 s for the total of second trials
				(3) Flaming or glowing to the clamp, or marking line		There shall be no flaming or glowing
				(4) Drop from specimen that ignite cotton.		There shall be no ignition
				NOTE Repeat the test when one specimen does not satisfy the test items (1) to (4), and the total flaming time of ten trials is between 51 s and 55 s. The specimens shall satisfy the specification in the repeated test		
Resistance to chemicals			—	There shall be no swell nor delamination	According to 9.2 (resistance to chemicals)	
Resistance to soldering			—	There shall be no considerable shrinkage, and no delamination of copper foil and base, nor swell	According to 9.3 (resistance to soldering heat)	
Solderability			—	The area of copper foil with good solderability shall be over 95 % of the foil.	According to 9.4 (solderability)	
Chemicals for processing of copper foil			—	The chemical for copper-foil treatment shall not affect etching of CCL, soldering nor adhesiveness of electrolytic plating	According to 9.5 (chemicals for processing of copper foil)	
Dimensional stability (Thickness of polyimide film: 25 μm)	After etching and drying	MD	%	± 0,15	According to 9.6 (dimensional stability)	
		TD				
	After etching and heating	MD		± 0,20		
		TD				
	After heating	MD		±0,10	According to Method D in Annex B of this standard	
		TD				

**Table 17 – Properties of CCL –
Non-adhesive type (two layers)/polyimide film base + copper foil (casting)**

Item			Unit	Specification			Test method JIS C 6471	
Observation			—	According to Table 9			According to 6.1 (observation)	
Size	Thickness		—	According to 5.4.1			According to 6.2.1 (thickness)	
	Width			According to 5.4.2 and 5.4.3			According to 6.2.2 (width)	
	Length						According to 6.2.3 (length)	
Resistivity	Normal		$\Omega \cdot \text{cm}$	$10^{12} \leq$			According to 7.1 (resistivity)	
	After water vapour adsorption			$10^{11} \leq$				
Surface resistivity	Normal		Ω	$10^{11} \leq$			According to 7.2 (surface resistivity)	
	After water vapour adsorption			$10^{10} \leq$				
Surface withstanding voltage AC 500 V, 1 min			—	There shall be no flash-over			According to 7.3 (surface withstanding voltage)	
Interlayer withstanding voltage AC 500 V, 1 min			—	There shall be no breakdown			According to 7.4 (interlayer withstanding voltage)	
Dielectric constant (1 MHz)			—	≤ 4.0			According to 7.5 (dielectric constant and loss tangent)	
Loss tangent (1 MHz)			—	≤ 0.01				
Peel strength of copper foil	Thickness of copper foil		—	$8 \leq < 18$	$18 \leq < 35$	$35 \leq$	According to 8.1 (peel strength of copper foil) (when the thickness of copper foil is less than 8 μm , electroplate copper on the foil as to attain the thickness of more than 8 μm)	
(Thickness of polyimide film: 25 μm)	Item	Normal	N/mm	$0.6 \leq$	$0.7 \leq$	$0.8 \leq$		
		After heating						
		Dipped into solder						
		Dipped into chemicals						
Bending (Bending radius is $R = 0.38 \text{ mm}$ for thickness of polyimide film: 25 μm)	Copper foil	Type	Copper foil	18	Cycle		200 $\leq$	According to 8.2 (bending)
				35			100 $\leq$	
				18			200 $\leq$	
				35			100 $\leq$	

Table 17 – Properties of CCL (continued)

Item			Unit	Specification	Test method JIS C 6471	
Flammability			—	Specimen shall satisfy the following specification.	According to 9.1 (flammability)	
				Item		Specification
				(1) Flaming time		Within 10 s for each time, and a total of less than 50 s for 10 trials
				(2) Flaming and glowing times		Less than 30 s for the total of second trials
				(3) Flaming or glowing to the clamp, or marking line		There shall be no flaming or glowing
				(4) Drop from specimen that ignite cotton		There shall be no ignition
NOTE Repeat the test when one specimen does not satisfy the test items (1) to (4), and the total flaming time of ten trials is between 51 s and 55 s. The specimens shall satisfy the specification in the repeated test						
Resistance to chemicals			—	There shall be no swell nor delamination	According to 9.2 (resistance to chemicals)	
Resistance to soldering			—	There shall be no considerable shrinkage, no delamination of copper foil and base nor swell	According to 9.3 (resistance to soldering heat)	
Solderability			—	The area of copper foil with good solderability shall be over 95 % of the foil	According to 9.4 (solderability)	
Chemicals for processing of copper foil			—	The chemical for copper-foil treatment shall not affect etching of CCL, soldering nor adhesiveness of electrolytic plating	According to 9.5 (chemicals for processing of copper foil)	
Dimensional stability (thickness of polyimide film: 25 μm)	After etching and drying	MD	%	Level 1: ± 0,20 Level 2: ± 0,10 Level 3: to be agreed by user and supplier Level X: to be agreed by user and supplier	According to 9.6 (dimensional stability)	
		TD				
	After etching and heating	MD		Level 1: ± 0,20 Level 2: ± 0,15 Level 3: ± 0,10 Level X: ± 0075 (only for single-sided board)		
		TD				
	After heating	MD		Level 1: ± 0,20 Level 2: ± 0,10 Level 3: to be agreed by user and supplier Level X: to be agreed by user and supplier	According to Method D in Annex B of this standard	
		TD				
NOTE The levels of dimensional stability are defined as:						
Level 1: 300 μm pitch for single-sided board and 400 μm pitch for double-sided board						
Level 2: 150 μm to 300 μm pitch for single-sided board and 250 μm to 400 μm pitch for double-sided board						
Level 3: 60 μm to 150 μm pitch for single-sided board and 125 μm to 250 μm pitch for double-sided board						
Level X: Less than 60 μm pitch for single-sided board						

**Table 18 – Properties of CCL –
Non-adhesive type (two layers)/polyimide film base + copper foil (sputter/plating)**

Item			Unit	Specification		Test method JIS C 6471
Observation			—	According to Table 9		According to 6.1 (observation)
Size	Thickness		—	According to 5.4.1		According to 6.2.1 (thickness)
	Width			According to 5.4.2 and 5.4.3		According to 6.2.2 (width)
	Length					According to 6.2.3 (length)
Resistivity	Normal		$\Omega \cdot \text{cm}$	$10^{13} \leq$		According to 7.1 (resistivity)
	After water vapour adsorption			$10^{12} \leq$		
Surface resistivity	Normal		Ω	$10^{11} \leq$		According to 7.2 (surface resistivity)
	After water vapour adsorption			$10^{10} \leq$		
Surface withstanding voltage AC 500 V, 1 min			—	There shall be no flash-over		According to 7.3 (surface withstanding voltage)
Interlayer withstanding voltage AC 500 V, 1 min			—	There shall be no breakdown		According to 7.4 (interlayer withstanding voltage)
Dielectric constant (1 MHz)			—	$\leq 4,0$		According to 7.5 (dielectric constant and loss tangent)
Loss tangent (1 MHz)			—	$\leq 0,07$		
Peel strength of copper foil (Thickness of polyimide film: 25 μm)	Thickness of copper foil		—	$8 \leq < 18$	$18 \leq < 35$	According to 8.1 (peel strength of copper foil) (when the thickness of copper foil is less than 8 μm , electroplate copper on the foil as to attain the thickness of more than 8 μm)
	Item	Normal	N/mm	$0,35 \leq$	$0,50 \leq$	
		After heating		$0,35 \leq$	$0,50 \leq$	
		Dipped into solder		$0,35 \leq$	$0,50 \leq$	
		Dipped into chemicals		To be agreed by user and supplier	$0,50 \leq$	
Bending (Bending radius is $R = 0,38\text{mm}$ for thickness of polyimide film: 25 μm)	Copper foil (plating thickness)	Cycle	To be agreed by user and supplier			According to 8.2 (bending)
		< 8 $8 \leq < 18$	$50 \leq$			

Table 18 – Properties of CCL (continued)

Item			Unit	Specification		Test method JIS C 6471	
Flammability			—	Specimen shall satisfy the following specification		According to 9.1 (flammability)	
				Item	Specification		
				(1) Flaming time	Within 10 s for each time, and a total of less than 50 s for 10 trials		
				(2) Flaming and glowing times	Less than 30 s for the total of second trials		
				(3) Flaming or glowing to the clamp, or marking line	There shall be no flaming or glowing		
				(4) Drop from specimen that ignite cotton.	There shall be no ignition		
				NOTE Repeat the test when one specimen does not satisfy the test items (1) to (4), and the total flaming time of ten trials is between 51 s and 55 s. The specimens shall satisfy the specification in the repeated test			
Resistance to chemicals			—	There shall be no swell or delamination		According to 9.2 (resistance to chemicals)	
Resistance to soldering			—	There shall be no considerable shrinkage, no delamination of copper foil and base nor swell.		According to 9.3 (resistance to soldering heat)	
Solderability			—	The area of copper foil with good solderability shall be over 95 % of the foil. (When the foil thickness is less than 8 μm, the copper shall be plated to the total thickness of more than 8 μm.)		According to 9.4 (solderability)	
Chemicals for processing of copper foil			—	The chemical for copper foil treatment shall not affect etching of CCL, soldering nor adhesiveness of electrolytic plating		According to 9.5 (chemicals for processing of copper foil)	
Dimensional stability (Thickness of polyimide film: 25 μm)	After etching and drying	MD	%	Level 1: ± 0,20 Level 2: ± 0,10 Level 3: to be agreed by user and supplier Level X: ± 0075 (only for single-sided board)		According to 9.6 (Dimensional stability)	
		TD					
	After etching and heating	MD		Level 1: ± 0,20 Level 2: ± 0,15 Level 3: ± 0,10 Level X: ± 0075 (only for single-sided board)			
		TD					
	After heating	MD		Level 1: ± 0,20 Level 2: ± 0,10 Level 3: to be agreed by user and supplier Level X: to be agreed by user and supplier		According to Method D in Annex B of this standard	
		TD					
NOTE The levels of dimensional stability are defined as:							
Level 1: 300 μm pitch for single-sided board and 400 μm pitch for double-sided board							
Level 2: 150 μm to 300 μm pitch for single-sided board and 250 μm to 400 μm pitch for double-sided board							
Level 3: 60 μm to 150 μm pitch for single-sided board and 125 μm to 250 μm pitch for double-sided board							
Level X: Less than 60 μm pitch for single-sided board							

**Table 19 – Properties of CCL –
Non-adhesive type (two layers)/polyimide film base + copper foil (laminate)**

Item			Unit	Specification			Test method JIS C 6471
Observation			—	To be agreed by user and supplier			According to 6.1 (observation)
Size	Thickness		—	According to 5.4.1			According to 6.2.1 (thickness)
	Width			According to 5.4.2 and 5.4.3			According to 6.2.2 (width)
	Length						According to 6.2.3 (length)
Resistivity	Normal		$\Omega \cdot \text{cm}$	$10^{12} \leq$			According to 7.1 (resistivity)
	After water vapour adsorption			$10^{11} \leq$			
Surface resistivity	Normal		Ω	$10^{11} \leq$			According to 7.2 (surface resistivity)
	After water vapour adsorption			$10^{10} \leq$			
Surface withstanding voltage AC 500 V, 1 min			—	There shall be no flash-over			According to 7.3 (surface withstanding voltage)
Interlayer withstanding voltage AC 500 V, 1 min			—	There shall be no breakdown			According to 7.4 (interlayer withstanding voltage)
Dielectric constant (1 MHz)			—	$\leq 4,0$			According to 7.5 (dielectric constant and loss tangent)
Loss tangent (1 MHz)			—	$\leq 0,01$			
Peel strength of copper foil (Thickness of polyimide film: 25 μm)	Thickness of copper foil		—	$8 \leq < 18$	$18 \leq < 35$	$35 \leq$	According to 8.1 (peel strength of copper foil) (when the thickness of copper foil is less than 8 μm , electroplate copper on the foil as to attain the thickness of more than 8 μm)
	Item	Normal	N/mm	$0,6 \leq$	$0,7 \leq$	$0,8 \leq$	
		After heating					
		Dipped into solder					
		Dipped into chemicals					
Bending (Bending radius is $R = 0,38$ mm for thickness of polyimide film: 25 μm)	Copper foil	Type	Copper foil	18	Cycle		According to 8.2 (bending)
				35	$75 \leq$		
		Etch			To be agreed by user and supplier		
		Type	18	$150 \leq$			
		Etch	35	To be agreed by user and supplier			

Table 19 – Properties of CCL (continued)

Item			Unit	Specification	Test method JIS C 6471	
Flammability			—	Specimen shall satisfy the following specification	According to 9.1 (flammability)	
				Item		Specification
				(1) Flaming time		Within 10 s for each time, and a total of less than 50 s for 10 trials
				(2) Flaming and glowing times		Less than 30 s for the total of second trials
				(3) Flaming or glowing to the clamp, or marking line		There shall be no flaming or glowing
				(4) Drop from specimen that ignite cotton	There shall be no ignition	
				NOTE Repeat the test when one specimen does not satisfy the test items (1) to (4), and the total flaming time of ten trials is between 51 s and 55 s. The specimens shall satisfy the specification in the repeated test		
Resistance to chemicals			—	There shall be no swell nor delamination	According to 9.2 (resistance to chemicals)	
Resistance to soldering			—	There shall be no considerable shrinkage, no delamination of copper foil and base nor swell	According to 9.3 (resistance to soldering heat)	
Solderability			—	The area of copper foil with good solderability shall be over 95 % of the foil	According to 9.4 (solderability)	
Chemicals for processing of copper foil			—	The chemical for copper foil treatment shall not affect the etching of CCL, soldering nor adhesiveness of electrolytic plating	According to 9.5 (chemicals for processing of copper foil)	
Dimensional stability (Thickness of polyimide film: 25 µm)	After etching and drying	MD	%	Level 1: ± 0,20 Level 2: ± 0,10 Level 3: to be agreed by user and supplier Level X: to be agreed by user and supplier	According to 9.6 (dimensional stability)	
		TD				
	After etching and heating	MD	Level 1: ± 0,20 Level 2: ± 0,15 Level 3: ± 0,10 Level X: ± 0075 (only for single-sided board)			
		TD				
	After heating	MD	Level 1: ± 0,20 Level 2: ± 0,10 Level 3: to be agreed by user and supplier Level X: to be agreed by user and supplier	According to Method D in Annex B of this standard		
		TD				
NOTE The levels of dimensional stability are defined as:						
Level 1: 300 µm pitch for single-sided board and 400 µm pitch for double-sided board						
Level 2: 150 µm to 300 µm pitch for single-sided board and 250 µm to 400 µm pitch for double-sided board						
Level 3: 60 µm to 150 µm pitch for single-sided board and 125 µm to 250 µm pitch for double-sided board						
Level X: Less than 60 µm pitch for single-sided board						

8 Package and labelling

CCL shall be packed in such a way as not to be damaged during shipping or storage. The label on the package shall be clearly legible, shall not fade easily, and shall show the following items. The label shall be attached to each product if there is a possibility of confusion of the products when the label is on the package only (machining direction, different composition of copper foil, etc.).

- a) Type designation
- b) Film direction (for example, machine direction) by an arrow
- c) Width and length
- d) Quantity
- e) Producer or its abbreviation
- f) Date of production or its abbreviation (if the date is apparent from its lot number, the date may be omitted)
- g) Production lot number