BSI

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IEC 249-2-13 : 1987

British Standard

Metal-clad base materials for printed wiring boards

Part 102. Copper-clad base materials

Section 102.13 Specification for flexible copper-clad polyimide film, general purpose grade

British Standards Institution

Contents

National foreword

This Section of BS 4584 has been prepared under the direction of the Electronic Components Standards Policy Committee. It is identical with both CENELEC harmonized document HD 313-2-13 S1 and IEC 249-2-13 : 1987 'Base materials for printed circuits' Part 2 : 'Specifications', Specification No. 13 'Flexible copper-clad polyimide film, general purpose grade', published by the International Electrotechnical Commission (IEC).

This Section is one of a series of specifications for base material for printed circuits. This series of specifications replaces the previously published Parts of BS 4584 which are listed below. The following list provides a guide to the relation between these withdrawn Parts and the new specifications. Note that inclusion in the list does not necessarily indicate an exact correspondence between the Parts but only a technical relationship.

Withdrawn Part	Replacement Section
2 (1972)	102.4 (1990)
3 (1972)	102.5 (1990)
4 (1989)	102.2 (1990)
5 (1972)	None
6 (1972)	None
7 (1989)	102.1 (1990)
8 (1972)	102.7 (1990)
9 (1977)	102.8 (1990)
10 (1977)	*102.15
11 (1977)	103.1 (1990)
12 (1977)	102.12 (1990)
13 (1977)	None
14 (1989)	102.6 (1990)
16 (1978)	102.10 (1990)

Cross-references

International standard	Corresponding British Standard
	BS 4584 Metal-clad base materials for printed wiring boards
IEC 249-1 : 1982	Part 1 : 1983 Methods of test (Identical)
IEC 249-3A : 1976	Part 103 : Special materials used in connection with printed circuits. Section 103.2 : 1990 Specification for copper foil for use in the manufacture of copper-clad base materials (Identical)

Compliance with a British Standard does not of itself confer immunity from legal obligations.

*In preparation.

BASE MATERIALS FOR PRINTED CIRCUITS

Part 2: Specifications
Specification No. 13: Flexible copper-clad polyimide film, general purpose grade

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1. Scope

This specification gives requirements for properties of flexible copper-clad polyimide film, general purpose grade.

Note. — To designate this material, the reference 249-2-13-IEC-PI-Cu may be used; if there is no risk of confusion, the type designation may be abbreviated to read IEC-249-2-13.

The specification includes optional requirements which apply only by agreement between purchaser and supplier. Copper-clad film complying with all the requirements not marked "optional" should be deemed to comply with this specification.

2. Materials and construction

The material consists of an insulating flexible film base with copper foil bonded to one or both sides, with or without the use of an adhesive. This specification does not cover laminates of polyimide with other films (e.g. perfluoro (ethylene/propylene), FEP, or polytetrafluoro-ethylene, PTFE).

2.1 *Insulating base*

2.1.1 *Polyimide film*

Polyimide film of preferred thicknesses and permitted tolerances as given in the following table when measured by the method of Sub-clause 3.14 of IEC Publication 249-1. Other thicknesses may be used by agreement between purchaser and supplier.

TABLE I

Preferred thicknesses and permitted tolerances of polyimide film

Nominal thickness		Maximum permitted tolerance at any point
μm	in	%
12.5	0.0005	±30
25	0.001	±20
50	0.002	±15
75	0.003	±10
125	0.005	±10

2.1.2 *Bonding medium*

A layer of adhesive may be used between the polyimide film and the metal foil.

2.2 *Metal foil*

Copper as specified in IEC Publication 249-3A.

2.3 *Preferred combinations of copper foil and polyimide film*

The nominal thicknesses in the table below assume the presence of an adhesive layer 15 μm (0.0006 in) thick between the copper and the film, and will thus need adjusting for any other thickness of adhesive.

TABLE II

	Copper foil		Polyimide film thickness μm (in)				
	Nominal thickness μm (in)	Mass per unit area g/m² (oz/ft²)	12.5 (0.0005)	25 (0.001)	50 (0.002)	75 (0.003)	125 (0.005)
			Nominal total thickness μm (in)				
Foil one side	18 (0.0007)	152 (0.5)	—	—	83 (0.0033)	—	—
	35 (0.0014)	305 (1)	—	75 (0.0029)	100 (0.0039)	125 (0.0049)	—
	70 (0.0028)	610 (2)	—	—	—	160 (0.0063)	—
Foil both sides	18 (0.0007)	152 (0.5)	—	—	—	—	—
	35 (0.0014)	305 (1)	—	—	150 (0.0059)	175 (0.0069)	—
	70 (0.0028)	610 (2)	—	—	—	—	—

3. Internal marking

Not applicable.

4. Electrical properties

TABLE III

Property	Test method (Sub-clause of IEC Publication 249-1)	Requirement
Surface resistance while in the humidity chamber (optional)	2.2	Under consideration
Surface resistance after recovery	2.2	100000 MΩ min.
Volume resistivity while in the humidity chamber (optional)	2.3	Under consideration
Volume resistivity after recovery	2.3	1000000 MΩm min. on films clad both sides only
Relative permittivity after damp heat and recovery (optional)	2.7	4.5 max.
Dielectric dissipation factor after damp heat and recovery (optional)	2.7	0.035 max.
Electrical strength (optional)	2.8	25 kV/mm (625 V/mil) min.

5. Non-electrical properties of the copper-clad film

When material is supplied in roll form, the requirements of Sub-clauses 5.1 and 5.2 shall apply only to material which is further than 6 mm from each edge.

5.1 *Appearance of the copper-clad face*

5.1.1 *Normal surface finish*

The copper-clad face shall be substantially free from blisters, wrinkles, pin-holes, deep scratches, pits and adhesive. Any discoloration or contamination shall be readily removable with a hydrochloric acid solution of density 1.02 g/cm^3 or with a suitable organic solvent.

5.1.2 *High-quality surface finish (optional)*

If a surface of high quality is essential for precious metal plating or fine line etching and is ordered by the purchaser, the following requirements shall apply in addition to those of Sub-clause 5.1.1 when inspected in accordance with Sub-clause 3.9 of IEC Publication 249-1.

The surface finish of the copper-clad face shall be such as not to conceal imperfections.

The surface of the copper foil shall be free from scratches of depth greater than 0.010 mm (0.0004 in). The total length of scratches of depth greater than 0.005 mm (0.0002 in) but not greater than 0.010 mm (0.0004 in) shall not exceed 1 m per square metre (1 yd per square yard) of the total area under test.

This requirement applies to the surface of 35 μm and 70 μm (305 g/m^2 and 610 g/m^2, 1 oz/ft^2 and 2 oz/ft^2) foils. Permitted scratches on surfaces of 18 μm (152 g/m^2, 0.5 oz/ft^2) foil are still under consideration.

The total area of all pin-holes in an area of 0.5 m^2 (5.4 ft^2) shall not exceed 0.012 mm^2 ($2 \cdot 10^{-5}$ in^2).

No material shall have more imperfections of the types listed than those permitted by table IV:

TABLE IV

Types, sizes and permitted number of imperfections

Types	Size (length unless otherwise indicated)		Number of imperfections permitted	
	Above mm (in)	Not above mm (in)	In any area of 1 m² (1.2 yd²)	In any area of 0.1 m² (1 ft²)
Inclusions in the copper surface	—	0.1 (0.004)	Any number	Any number
	0.1 (0.004)	0.25 (0.01)	30	4
	0.25 (0.01)	—	0	0
Indentations*	—	0.25 (0.01)	Any number	Any number
	0.25 (0.01)	3.0 (0.12) or width 1.0 (0.04)	30	7
	0.5 (0.02)		11	3
	1.25 (0.05)		3	1
	3.0 (0.12) or width 1.0 (0.04)	—	0	0

* This requirement may be stated: The maximum permitted number of indentations in any area of 1 m² with length greater than 0.25 mm (0.01 in) is 30, of which none should exceed a length of 3.0 mm (0.12 in) or width of 1.0 mm (0.04 in), three may exceed a length of 1.25 mm (0.05 in) and 11 may exceed a length of 0.5 mm (0.02 in).

Note. — For cut panels smaller than 0.1 m² (1 ft²) in area the numbers and maximum sizes of imperfections may be agreed upon between purchaser and supplier.

5.2 *Inclusions between film and copper*

There shall be no more areas of delamination observed between the film and the copper caused by inclusions of air or foreign matter than those permitted in table V, when the material is inspected in accordance with the method of Sub-clause 3.9 of IEC Publication 249-1.

TABLE V

Permitted inclusions between film and copper

Maximum dimension of delaminated area mm (in)		Maximum permitted number of inclusions	
Above	Not above	In any area of 1 m² (10 ft²)	In any area of 0.1 m² (1 ft²)
—	0.25 (0.01)	Any number	Any number
0.25 (0.01)	0.5 (0.02)	150	30
0.5 (0.02)	1.0 (0.04)	30	8
1.0 (0.04)	2.0 (0.08)	10	2
2.0 (0.08)	—	0	0

Notes 1. — (Sub-clause 5.2) — For any panels smaller than 0.1 m² (1 ft²) in area the numbers and maximum sizes of delaminated areas permitted should be as agreed between purchaser and supplier.

2. — (Sub-clauses 5.1 and 5.2) — Materials supplied in roll form: Materials failing to meet the requirements of Sub-clauses 5.1 or 5.2 may be left on the roll to avoid the need for cutting and splicing provided that failed lengths, which should be considered to be not less than 0.3 m (1 ft) long, are clearly marked with a "flag" which should be visible from the edge of the roll, and provided also that failed lengths are not included in any statement of material quantity claimed to meet this specification.

5.3 *Thickness*

When measured in accordance with Sub-clause 3.14 of IEC Publication 249-1, the overall thickness of the copper-clad film shall not differ at any point from the sum of the nominal thicknesses of its component layers by more than the permitted percentage tolerance allowed in Sub-clause 2.1.1 for the film used.

For the preferred combinations of copper and film using adhesive layers 15 μm (0.0006 in) thick, the total nominal thicknesses are shown in Sub-clause 2.3.

5.4 *Properties related to the copper foil bond*

TABLE VI

Property	Test method (Sub-clause of IEC Publication 249-1)	Nominal copper foil thickness	Requirement
Peel strength as received	3.6	35 μm and heavier (305 g/m², 1 oz/ft²) Less than 35 μm (305 g/m², 1 oz/ft²)	Not less than 0.7 N/mm (4.0 lbf/in) Not less than 0.5 N/mm (2.9 lbf/in)
Peel strength after conditioning 30 min at 125 °C and heat shock for 10 s	3.6.2	35 μm and heavier (305 g/m², 1 oz/ft²) Less than 35 μm (305 g/m², 1 oz/ft²) Any	Not less than 0.7 N/mm (4.0 lbf/in) Not less than 0.5 N/mm (2.9 lbf/in) No blistering or delamination
Peel strength after dry heat for 30 min at 200 °C (optional)	3.6.3	35 μm and heavier (305 g/m², 1 oz/ft²) Less than 35 μm (305 g/m², 1 oz/ft²) Any	Not less than 0.7 N/mm (4.0 lbf/in) Not less than 0.5 N/mm (2.9 lbf/in) No blistering or delamination
Retention of peel strength after immersion in solvent Solvents: 1,1,1-trichloroethane, isopropyl alcohol, methylethylketone, methylene chloride	3.6.6 but duration 3 min instead of 10 min	Any	Not less than 75% No blistering, delamination, tackiness or colour change
Retention of peel strength after simulated plating (optional)	3.6.5 but current density 50A/m² instead of 215A/m²	Any	Not less than 75% No blistering, delamination, tackiness or colour change

5.5 *Flexural fatigue*

TABLE VII

Property	Test method (Sub-clause of IEC Publication 249-1)	Nominal copper foil thickness	Requirement
Flexural fatigue (optional)	3.12	18 μm (152 g/m², 0.5 oz/ft²) 35 μm (305 g/m², 1 oz/ft²) 70 μm (610 g/m², 2 oz/ft²)	50 cycles (minimum) 100 cycles (minimum) 75 cycles (minimum)

5.6 *Solderability*

5.6.1 *Plate finish* (without further surface treatment)

When the sheet is tested by the method described in Sub-clause 3.10 of IEC Publication 249-1 and in accordance with the times and temperatures specified below, the soldered areas shall be covered with a smooth and bright solder coating. Scattered imperfections, such

as pin-holes, shall not occur on more than 5% of the surface and shall not be concentrated in one area.

For the acceptability of the unwetted or dewetted areas, the criteria of Figure 9 of IEC Publication 249-1 apply.

At least six specimens out of each batch of 10 shall pass the test.

After conditioning 30 min at 125 °C:

a) Wetting

TABLE VIII

Thickness of copper	Maximum wetting time	Temperature
µm (in)	s	°C
35 (0.0014) (305 g/m², 1 oz/ft²)	2	235^{+5}_{0}
70 (0.0028) (610 g/m², 2 oz/ft²)	3	235^{+5}_{0}

b) Dewetting

Test specimens shall remain in contact with the molten solder for 5 ± 1 s at $235\ ^{+5}_{0}$ °C.

Note. — For thicknesses of copper greater than 70 µm (610 g/m², 2 oz/ft²), the wetting and dewetting times may be agreed upon between purchaser and supplier.

5.6.2 *Mat finish*

Not applicable.

5.7 *Dimensional stability*

TABLE IX

Property	Test method (Sub-clause of IEC Publication 249-1)	Requirement
Dimensional change due to etching (process step 1 only)	3.11	2.5 µm/mm maximum in either direction
Dimensional change due to etching and heating (process steps 1 and 2) (optional)	3.11	3.5 µm/mm maximum in either direction

6. Non-electrical properties of the base material after complete removal of the copper foil

6.1 *Appearance of the base material*

Not specified.

6.2 *Flexural strength*

Not applicable.

6.3 *Flammability*

Not applicable.

6.4 *Water absorption*

Not specified.

6.5 *Measling*

Not applicable.

7. Packaging and marking

7.1 *Packaging*

Material supplied either in roll, sheet or panel form shall be adequately packed in cases or crates to avoid damage and contamination during transit and storage.

7.2 *Marking*

As the product is not of defined flammability, no red marks shall be used on the label. Each package or roll shall be labelled as follows:

a) to identify the manufacturer;
b) to identify the film as polyimide;
c) to show the nominal thickness of the film;
d) to show the type of copper (see Sub-clause 2.2);
e) to show the nominal thickness of the copper foil;
f) to show whether the foil is on one or both sides;
g) to show whether or not an adhesive is used and if so, the nominal thickness and type of each adhesive layer;
h) to identify the batch or roll number or both;
i) to show the nominal length and width of material on the roll;
j) to show the machine direction (material supplied in sheets only).

This information may be incorporated into the manufacturer's reference code.

8. Acceptance testing

Not specified.

9. Additional requirements

9.1 *For material supplied in roll form*

9.1.1 Material supplied in roll form shall be firmly reeled on formers of an internal diameter not less than 50 mm (2 in), and as agreed between purchaser and supplier.

9.1.2 The tolerance from the nominal width of material supplied in rolls as manufactured shall not exceed ± 25 mm (1 in).

9.1.3 The tolerance from the nominal width of material supplied in rolls cut to specified width shall not exceed $^{+3}_{0}$ mm ($^{+\ 0.12}_{0}$ in).

9.1.4 The tolerance in length of material supplied in rolls shall not exceed ± 1% of the nominal length.

9.1.5 There shall be no more than two splices in any 100 m (330 ft) length of a roll, except that in material cut to specified width there shall be no more than five splices in any 100 m (330 ft) length.

9.2 *For material supplied in sheet form*

The tolerance in length and width for sheets cut to specified size shall not exceed $^{+3}_{0}$ mm ($^{+0.12}_{0}$ in).

Publications referred to

See national foreword.

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Electronic Components Standards Policy Committee (ECL/-) to Technical Committee ECL/19, upon which the following bodies were represented:

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