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INTERNATIONAL STANDARD

Materials for printed boards and other interconnecting structures – Part 4-16: Sectional specification set for prepreg materials, unclad (for the manufacture of multilayer boards) – Multifunctional non-halogenated epoxide woven E-glass prepreg of defined flammability (vertical burning test) for lead-free assembly

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International Standard IEC 61249-4-16 has been prepared by IEC technical committee 91: Electronics assembly technology.

The text of this standard is based on the following documents:

FDIS	Report on voting
91/852/FDIS	91/864/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61249 series, under the general title *Materials for printed boards and other interconnecting structures*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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A bilingual version of this publication may be issued at a later date.

MATERIALS FOR PRINTED BOARDS AND OTHER INTERCONNECTING STRUCTURES –

Part 4-16: Sectional specification set for prepreg materials, unclad (for the manufacture of multilayer boards) – Multifunctional non-halogenated epoxide woven E-glass prepreg of defined flammability (vertical burning test) for lead-free assembly

1 Scope

This part of IEC 61249 gives requirements for properties of prepreg that are mainly intended to be used as bonding sheets in connection with laminates according IEC 61249-2-37 when manufacturing multilayer boards according to IEC 62326-4. Multilayer boards comprised of these materials are suitable for lead-free assembly processes. This material may also be used to bond other types of laminates.

Prepreg according to this standard is of defined flammability (vertical burning test). The flammability rating on fully cured prepreg is achieved through the use of non-halogenated flame retardants contained as an integral part of the polymeric structure. After curing of the prepreg according to the supplier's instructions, the glass transition temperature is defined to be 150 °C and 200 °C.

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.

IEC 61189-2:2006, *Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 2: Test methods for materials for interconnection structures*

IEC 61249-2-37, *Materials for printed boards and other interconnecting structures – Part 2-37: Reinforced base materials, clad and unclad – Modified non-halogenated epoxide woven E-glass laminate sheets of defined flammability (vertical burning test), copper-clad for lead-free assembly*

IEC 62326-4, *Printed boards – Part 4: Rigid multilayer printed boards with interlayer connections – Sectional specification*

ISO 11014-1:1994, *Safety data sheet for chemical products – Part 1: Content and order of sections*

3 Materials and construction

The prepreg consists of a reinforcing E-glass fabric which is impregnated modified epoxide resin and partially cured to the B-stage.

3.1 Reinforcement

Woven E-glass as specified in the future IEC 61249-6-3 (under consideration), woven E-glass fabric (for the manufacture of prepreg and copper-clad laminate).

3.2 Resin system

Majority di-functional non-halogenated epoxide and modified non-halogenated epoxide with a glass transition temperature after curing according to the manufacturer's instructions of 150 °C to 200 °C. The maximum total halogens contained in the resin plus reinforcement matrix is 1500 ppm with a maximum chlorine of 900 ppm and maximum bromine being 900 ppm.

The curing agent shall not be dicyandiamide. The flammability rating is achieved through the use of bromine reacted into the polymer. Inorganic fillers may be used. Contrast agents may be added to enhance processing such as automated optical inspection (AOI).

Its flame resistance is defined in terms of the flammability requirements of 4.3.2.

4 Properties

4.1 Properties related to the appearance of the prepreg

The prepreg shall be substantially free from defects that may have an impact on the material's fitness for use for the intended purpose.

For the following specific defects, the requirements of method 2V01 (under consideration) of IEC 61189-2 will apply as soon as this test will be available.

4.1.1 Dewetted areas (fish eyes)

Dewetted areas with a diameter >10 mm are not permissible.

Dewetted areas with a diameter ≤10 mm are permitted to an extent of a maximum 10 fish eyes in any 300 mm × 300 mm area of the prepreg.

4.1.2 Broken filaments

When judging the presence of broken filaments, not only are their size and frequency of occurrence important for assessing acceptability, but the flow characteristic of the prepreg shall also be taken into consideration. The acceptance conditions for broken filaments shall be as agreed upon between user and supplier.

4.1.3 Distortion

When the prepreg will be tested in accordance with test method 2M29 (under consideration) of IEC 61189-2, the distortion or non-perpendicular orientation of the fill or weft yarns in the glass fabric shall not exceed 10 % measured over any 300 mm test distance.

4.1.4 Creases

Creases caused by handling of the prepreg where only a negligible loss of resin has occurred are permitted.

Creases where the glass yarns are exposed due to loss of resin are not permitted.

4.1.5 Edge conditions

Cut-to-size panels shall have even edges and shall not show loss of resin at the edge due to the cutting process of more than 2 mm. Excessive occurrence of resin dust released during the cutting shall be removed before packaging for shipment.

4.2 Properties related to B-stage prepreg

A number of characteristics can describe thickness, reactivity and rheology of B-stage prepreg. The choice of characteristics to be used as qualification and quality conformance testing as well as the nominal performance levels are as agreed upon between user and supplier.

Several of the characteristics shown below are interrelated and should not be specified individually. Ordering requirements should preferably be restricted to the glass style, one characteristic marked (a) in combination with one characteristic marked (b). One or both of the optional characteristic (c) of B-stage prepreg may be included.

Glass style

Thickness parameter

- Resin content (a)
- Treated weight (a)

Reactivity/rheology parameter

- Resin flow (b)
- Scaled flow thickness (b)
- Melt viscosity (b)
- Cured thickness (b)

Optional parameter

- Volatile content (c)
- Gel time (c)

4.2.1 Resin content

When tested in accordance with test method 2C03 or 2C10 of IEC 61189-2, the nominal resin content shall be as agreed upon between user and supplier.

The tolerance around the ordered nominal value shall be ±3 %, e.g. (45 ± 3) %.

4.2.2 Treated weight

When tested in accordance with test method 2C03 of IEC 61189-2, the nominal treated weight shall be as agreed upon between user and supplier.

The tolerance around the ordered nominal value shall be ±3 %, e.g. (350 ± 10,5) g.

4.2.3 Resin flow

When tested in accordance with test method 2M09 of IEC 61189-2, the nominal resin flow shall be as agreed upon between user and supplier.

The tolerance around the ordered nominal value shall be ±5 %, e.g. (25 ± 5) %.

4.2.4 Scaled flow thickness

When tested in accordance with test method 2M26 of IEC 61189-2, the nominal scaled flow and the tolerance shall be as agreed upon between user and supplier.

4.2.5 Melting viscosity

When tested in accordance with test method 2C09 of IEC 61189-2, the nominal melt viscosity shall be as agreed upon between user and supplier.

The tolerance around the ordered nominal value shall be ±20 m Pa s, e.g. (240 ± 20) m Pa s.

4.2.6 Gel time

When tested in accordance with test method 2C02 of IEC 61189-2, the nominal gel time shall be as agreed upon between user and supplier.

The tolerance around the ordered nominal value shall be ±20 s, e.g. (160 ± 20) s.

4.2.7 Volatile content

When tested in accordance with test method 2C04 of IEC 61189-2, the volatile content shall be 0,75 % maximum.

4.3 Properties related to prepreg after curing

4.3.1 Electric strength

A total of 2 plies of prepreg of minimum size 300 mm × 300 mm shall be bonded together and cured in accordance with the manufacturer's recommendations whereupon the thickness shall be determined using a micrometer.

When tested in accordance with test method 2E11 of IEC 61189-2, the minimum electric strength shall be 25 V/μm.

4.3.2 Flammability

A number of plies of minimum size 300 mm × 300 mm of the prepreg under test shall be bonded together and fully cured in accordance with the manufacturer's recommendations. The number of plies shall be chosen so that a specimen thickness of approximately (0,4 to 0,5) mm is obtained as measured with a micrometer.

When tested in accordance with test method 2C06 of IEC 61189-2, the flammability shall be as shown in Table 1.

Table 1 – Flammability, vertical burning test

Property	Test method (IEC 61189-2)	Requirements
Flammability	2C06	**Designation**
		FV 0
	Flaming combustion time after each application of the flame for each test specimen	≤10 s
	Total flaming combustion time for the 10 flame applications for each set of five specimens	≤50 s
	Glowing combustion time after the second removal of the test flame	≤30 s
	Flaming or glowing combustion up to the holding clamp	None
	Dripping flaming particles that ignite the tissue paper	None

4.3.3 Relative permittivity and dissipation factor

A total of 2 plies of prepreg of minimum size 300 mm × 300 mm shall be bonded together and fully cured in accordance with the manufacturer's recommendations whereupon the thickness shall be determined using a micrometer.

When tested in accordance with test method 2E10 of IEC 61189-2, the relative permittivity and dissipation factor at 1 MHz shall be 5,4 and 0,035 maximum respectively.

4.3.4 Cured thickness

The nominal thickness and the tolerance of the cured prepreg shall be as agreed upon between user and supplier. The prepreg under test shall be bonded together and fully cured in accordance with the manufacturer's recommendations. The test method shall be as agreed upon between user and supplier.

4.3.5 Glass transition temperature (Tg)

The glass transition temperature of the cured prepreg shall be (150 – 200) °C as determined by test method 2M10 or 2M11 of IEC 61189-2. The prepreg under test shall be bonded together and fully cured in accordance with the manufacturer's recommendations.

4.3.6 Decomposition temperature (Td)

The requirement for decomposition temperature is found in Table 2. The prepreg under test shall be bonded together and fully cured in accordance with the manufacturer's recommendations.

Table 2 – Decomposition temperature requirements

Property	Test method (IEC 61189-2)	Requirements
Decomposition temperature	2MXX	≥325 °C

4.3.7 Thermal resistance

The requirements for thermal resistance are found in Table 3. The prepreg under test shall be bonded together and fully cured in accordance with the manufacturer's recommendations. The specimen shall not have copper foil on any layer.

Table 3 – Thermal resistance requirements

Property	Test method (IEC 61189-2)	Requirements
T260	2MXX	≥30 min
T288		≥5 min
T300		TBD

4.3.8 Z-axis expansion

The requirements for Z-axis expansion are found in Table 4. The prepreg under test shall be bonded together and fully cured in accordance with the manufacturer's recommendations.

Table 4 – Z-axis expansion requirements

Property	Test method (IEC 61189-2)	Requirements
Z-axis alpha 1	2MXX	≤60 ppm / °C
Z-axis alpha 2		≤300 ppm / °C
Z-axis % 50 °C to 260 °C		3,5 % maximum

5 Delivery form

Prepreg may be ordered and delivered as rolls, sheets or cut panels.

5.1 Rolls

Roll sizes shall be as agreed upon between user and supplier. For rolls ≥50 m in length, cut-outs from quality conformance inspection are allowed. The size of the roll delivered by the supplier shall not deviate by more than +20/-0 mm in the width and ±5 m in length from the ordered size. Extra linear meters shall be added to compensate for any cut-outs for quality conformance testing.

5.2 Sheets

Sheet sizes shall be as agreed upon between user and supplier. The size of the sheet delivered shall not deviate by more than +20/-0 mm from the ordered size.

5.3 Cut panels

Cut panel sizes shall be as agreed upon between user and supplier. The size of the cut panels delivered shall not deviate by more than ±3 mm from the ordered size.

6 Quality assurance

6.1 Quality system

The supplier shall operate a quality system, ISO 9000 or similar, to support quality conformance inspection.

The supplier shall operate a quality system, ISO 14000 or similar, to support environmental considerations.

6.2 Responsibility for inspection

The supplier is responsible for the inspection of the manufactured material. Inspection is auditable by the purchaser or an appointed third party.

6.3 Qualification inspection

Prepregs furnished under this standard shall be qualified. Qualification testing shall be performed to demonstrate the manufacturer's ability to meet the requirements of this standard. Qualification testing shall be conducted at a laboratory in compliance with IEC laboratory requirements. The manufacturer shall retain on file the data which supports that the materials meet this standard and shall be readily available for review upon request.

6.4 Quality conformance inspection

The supplier shall operate a quality plan to assure product conformance to this standard. Such a quality plan, when appropriate, should utilize statistical methods rather than lot-by-lot inspection. It is the responsibility of the supplier based on the quality plan to determine the frequency of test to assure conforming products.

A combination of the following techniques may be used to show compliance with the requirements which can be used to reduce the frequency of testing. The data supporting the reduction of testing frequency shall be available for review upon request.

– In process parameter control
– In process inspection
– Periodic final inspection
– Final lot inspection

6.5 Certificate of conformance

The supplier shall, on request from the purchaser, issue a certificate of conformance to this standard in electronic or paper format.

6.6 Safety data sheet

A safety data sheet in accordance with ISO 11014-1 shall be available for products manufactured and delivered in accordance with this standard.

7 Packaging and marking

Prepreg in rolls, sheets and cut panels shall be packaged in a manner which will provide adequate protection against deterioration and physical damage during shipment and storage.

If not otherwise specified in the purchase order, prepreg shall be marked on the smallest package with the manufacturer's designation, lot number and date of manufacture.

The shipping container shall have a label that shall remain securely affixed and legible during normal handling. Location of the label and the type of marking shall be as specified in the drawing or ordering data, or if not specified shall be the supplier's standard labelling and marking. The following information is to be included:

a) type of material;
b) manufacturer's designation;
c) lot number;
d) date of manufacture
e) quantity;
f) dimensions;
g) gross weight;
h) manufacturer's name and address;
i) date of packaging.

8 Shelf life

Prepreg shall be capable of being stored at either of the described conditions below for the specified time and still be fit for its intended use.

Condition 1:
Temperature ≤5 °C, relative humidity not specified, minimum 6 months after shipping to the customer.

Condition 2:
Temperature ≤20 °C, relative humidity ≤50 %, minimum 3 months after shipment to the customer.

Prepreg should not be stored in a catalytic environment such as UV light or excessive radiation. Material that has been stored at lower temperature should be allowed to equilibrate to ambient temperature before the packaging is opened to avoid condensation of moisture on the prepreg itself.

9 Ordering information

The purchase order shall include the following details.

a) A reference to this specification
b) Type of material
c) Size
d) Glass style
e) The selected thickness parameter and nominal value
f) The selected reactivity/rheology parameter and nominal value
g) The selected optional parameter and nominal value (if any)
h) Request for certificate of conformance if applicable

Bibliography

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

IEC 61249-2-7, *Materials for printed boards and other interconnecting structures – Part 2-7: Reinforced base materials clad and unclad – Epoxide woven E-glass laminated sheet of defined flammability (vertical burning test), copper-clad*

IEC 61249-2-8, *Materials for printed boards and other interconnecting structures – Part 2-8: Reinforced base materials clad and unclad – Modified brominated fibreglass reinforced laminated sheets of defined flammability (vertical burning test), copper-clad*

IEC 61249-6-3, *Materials for printed boards and other interconnecting structures – Part 6-3: Reinforcements – Woven fibreglass fabrics* (under consideration)

ISO 9000 family, *Global management standards*

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