IEC 62788-1-1

Edition 1.0 2024-09

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Measurement procedures for materials used in photovoltaic modules – Part 1-1: Encapsulants – Polymeric materials used for encapsulation

Procédures de mesure des matériaux utilisés dans les modules photovoltaïques – Partie 1-1: Encapsulants – Matériaux polymères utilisés pour l'encapsulation



IEC 62788-1-1:2024-09(en-fr)



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Procédures de mesure des matériaux utilisés dans les modules photovoltaïques – Partie 1-1: Encapsulants – Matériaux polymères utilisés pour l'encapsulation

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MEASUREMENT PROCEDURES FOR MATERIALS USED IN PHOTOVOLTAIC MODULES –

Part 1-1: Encapsulants – Polymeric materials used for encapsulation

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IEC 62788-1-1 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems. It is an International Standard.

The text of this International Standard is based on the following documents:

Draft	Report on voting
82/2239/FDIS	82/2261/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 62788 series, published under the general title *Measurement procedures for materials used in photovoltaic modules*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
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MEASUREMENT PROCEDURES FOR MATERIALS USED IN PHOTOVOLTAIC MODULES –

Part 1-1: Encapsulants – Polymeric materials used for encapsulation

1 Scope

The encapsulant fulfils the purposes of optically coupling the cell to external radiation; mechanically attaching and holding module components in their relative positions; electrically isolating module components; thermally coupling module components; and chemically protecting module components (e.g., by limiting the concentration and transport of water and/or oxygen). This part of IEC 62788 defines test methods and reporting requirements for characteristics (optical, mechanical, electrical, thermal, and chemical) of non-rigid polymeric materials (e.g., poly(ethylene-co-vinyl acetate), EVA) intended for use in terrestrial photovoltaic (PV) modules as polymeric encapsulants.

Typically, encapsulants are considered functional insulators, i.e., they provide electrical insulation when present, but may not meet the requirements of relied upon insulation. Requirements related to relied upon insulation are identified in IEC 61730-1 and IEC 62788-2-1.

The test methods in this document define how to characterize encapsulant materials in a manner representative of how they will be used in the module, which includes combination with other components such as frontsheets, backsheets, adhesives, edge seals, or glass. The methods described in this document support and supplement the safety- and performance-related tests defined on the PV module level, as defined in IEC 61730-2 and IEC 61215-2. This document also defines test methods for general assessment of material characteristics of polymeric encapsulants.

The test methods described in this document may be used for the purposes of: datasheet reporting (aiding module design or material research and development); process and manufacturing control (e.g., incoming or outgoing inspection); application in module safety and design type qualification protocols; or reliability and durability study/standards development.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 61215-2, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test procedures*

IEC 61730-1:2023, *Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction*

IEC 61730-2, *Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing*

IEC 62788-1-2, *Measurement procedures for materials used in photovoltaic modules – Encapsulants – Part 1-2: – Measurement of volume resistivity of photovoltaic encapsulants and other polymeric materials*

IEC 62788-1-4, *Measurement procedures for materials used in photovoltaic modules – Encapsulants – Part 1-4: – Measurement of optical transmittance and calculation of the solar-weighted photon transmittance, yellowness index, and UV cut-off wavelength*

IEC 62788-1-5, *Measurement procedures for materials used in photovoltaic modules – Encapsulants – Part 1-5: Measurement of change in linear dimensions of sheet encapsulation material resulting from applied thermal conditions*

IEC 62788-1-6, *Measurement procedures for materials used in photovoltaic modules – Encapsulants – Part 1-6: Test methods for determining the degree of cure in Ethylene-Vinyl Acetate*

IEC 62788-1-7, *Measurement procedures for materials used in photovoltaic modules – Part 1-7: Optical durability of transparent polymeric PV packaging materials – Test procedure*

IEC TS 62788-2:2024, *Measurement procedures for materials used in photovoltaic modules – Part 2: Polymeric materials – Frontsheets and backsheets*

IEC 62788-2-1, *Polymeric materials for photovoltaic (PV) modules – Part 2-1: Safety requirements for polymeric frontsheet and backsheet*

IEC 62788-5-1:2020, *Measurement procedures for materials used in photovoltaic modules – Part 5-1: Edge seals – Suggested test methods for use with edge seal materials*

IEC 62788-6-2:2020, *Measurement procedures for materials used in photovoltaic modules – Part 6-2: General tests – Moisture permeation testing with polymeric films*

IEC TS 62788-6-3, *Measurement procedures for materials used in photovoltaic modules – Part 6-3: Adhesion testing for PV module laminates using the single cantilevered beam (SCB) method*

IEC TS 62788-7-2, *Measurement procedures for materials used in photovoltaic modules – Part 7-2: Environmental exposures – Accelerated weathering tests of polymeric materials*

IEC TS 62915, *Photovoltaic (PV) modules – Type approval, design and safety qualification – Retesting*

IEC 62941, *Terrestrial photovoltaic (PV) modules – Quality system for PV module manufacturing*

ISO 48-4, *Rubber, vulcanized or thermoplastic – Determination of hardness – Part 4: Indentation hardness by durometer method (Shore hardness)*

ISO 48-9, *Rubber, vulcanized or thermoplastic – Determination of hardness – Part 9: Calibration and verification of hardness testers*

ISO 62, *Plastics – Determination of water absorption*

ISO 291:2008, *Plastics – Standard atmospheres for conditioning and testing*

ISO 489, *Plastics – Determination of refractive index*

ISO 536, *Paper and board – Determination of grammage*

ISO 1183-1, *Plastics – Methods for determining the density of non-cellular plastics – Part 1: Immersion method, liquid pycnometer method and titration method*

ISO 1183-2, *Plastics – Methods for determining the density of non-cellular plastics – Part 2: Density gradient column method*

ISO 6721-1:2019, *Plastics – Determination of dynamic mechanical properties – Part 1: General principles*

ISO 6721-4, *Plastics – Determination of dynamic mechanical properties – Part 4: Tensile vibration – Non-resonance method*

ISO 8510-2, *Adhesives – Peel test for a flexible-bonded-to-rigid test specimen assembly – Part 2: 180 degree peel*

ISO 9001, *Quality management systems – Requirements*

ISO 11357-1, *Plastics – Differential scanning calorimetry (DSC) – Part 1: General principles*

ISO 11357-2, *Plastics – Differential scanning calorimetry (DSC) – Part 2: Determination of glass transition temperature and glass transition step height*

ISO 11357-3, *Plastics – Differential scanning calorimetry (DSC) – Part 3: Determination of temperature and enthalpy of melting and crystallization*

ISO 11358-1, *Plastics – Thermogravimetry (TG) of polymers – Part 1: General principles*

ISO 11359-1, *Plastics – Thermomechanical analysis (TMA) – Part 1: General principles*

ISO 11359-2, *Plastics – Thermomechanical analysis (TMA) – Part 2: Determination of coefficient of linear thermal expansion and glass transition temperature*

ISO 11502, *Plastics – Film and sheeting – Determination of blocking resistance*

ISO 15106-2, *Plastics – Film and sheeting – Determination of water vapour transmission rate – Part 2: Infrared detection sensor method*

ISO 15106-3, *Plastics – Film and sheeting – Determination of water vapour transmission rate – Part 3: Electrolytic detection sensor method*

ISO 22007-4, *Plastics – Determination of thermal conductivity and thermal diffusivity – Part 4: Laser flash method*

ASTM D2240*, Standard Test Method for Rubber Property – Durometer Hardness*

ASTM D3418*, Standard Test Method for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
adhesive failure
de-bonding occurring between the adhesive and the adherent (different from cohesive failure within the adhesive material)

3.2
cohesive failure
failure by fracture, with crack propagation through the bulk of a material

3.3
encapsulant
material used between the substrate and superstrate to provide environmental protection for photovoltaic cells in a photovoltaic module

[SOURCE: IEC TS 61836:2016, 3.1.30.]

3.4
Fickian
descriptive term for a material for which the diffusivity is constant, independent of the concentration of the permeant within the experimental uncertainty

[SOURCE: IEC 62788-6-2:2020, 3.1.2]

3.5
module junction box
j-box
combination of parts, such as boxes, covers, cover-plates, lids, box extensions, accessories, etc., providing after assembly and installation at the photovoltaic-module in normal use, an appropriate protection against external influences, and a defined protection against contact with enclosed live parts from any accessible direction

[SOURCE: IEC 62790:2020, 3.1]

3.6
optional test
test which is not required to be performed, but which may be performed

3.7
polymeric materials
materials that are either natural or synthetic; are primarily composed of chained monomers, combinations of monomers, or combined polymers; and may contain cross-linking agents, fillers, colorants, and other additives

3.8
release layer
film material with a thickness of 50 µm to 250 µm that is inserted in a layer stack before lamination to render the adhesion between interfaces inactive

Note 1 to entry: Examples of suitable release materials are fluoropolymer sheets (e.g., PTFE, FEP, ETFE) as well as silicone treated sheets (see IEC TS 62788-2).

3.9
relied upon insulation
RUI
system providing protection against electric shock in the final application, with material's requirements for thickness, thermal endurance and resistance against environmental stress factors

[SOURCE: IEC 61730-1:2023, 3.4.12]

3.10
required test
test which is required to be performed (e.g., for datasheet reporting), including module qualification

3.11
storage modulus
real part of the complex modulus

[SOURCE: ISO 6721-1:2001, 3.2]

3.12
substrate
backsheet
BS
(combination of) outer layer(s) of the PV module, located as substrate on the back of the PV module and providing protection of the inner components of the module from external stresses and weather elements, as well as providing electrical insulation between live parts and accessible surfaces

Note 1 to entry: IEC TS 62788-2 provides details on the required material properties of polymeric backsheets, while IEC 62788-2-1 provides the safety requirements for polymeric backsheets.

[SOURCE: IEC TS 62788-2:2024, 3.4]

3.13
superstrate
frontsheet
FS
(combination of) outer layer(s) of the PV module, located as superstrate on the front side of the PV module and providing protection of the inner components of the module from external stresses and weather elements, as well as providing electrical insulation between live parts and accessible surfaces

Note 1 to entry: IEC TS 62788-2 provides details on the required material properties of polymeric frontsheets, while IEC 62788-2-1 provides the safety requirements for polymeric frontsheets.

[SOURCE: IEC TS 62788-2:2024, 3.13]