



TECHNICAL SPECIFICATION



Measurement procedures for materials used in photovoltaic modules – Part 2: Polymeric materials – Frontsheets and backsheets

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MEASUREMENT PROCEDURES FOR MATERIALS
USED IN PHOTOVOLTAIC MODULES –****Part 2: Polymeric materials – Frontsheets and backsheets**

FOREWORD

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IEC TS 62788-2 has been prepared by IEC Technical Committee 82: Solar photovoltaic energy systems. It is a Technical Specification.

This second edition cancels and replaces the first edition published in 2017. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) With revision of IEC 61730-1 the requirements for the polymeric front- and backsheet have been moved from IEC 61730-1 into IEC 62788-2-1. This is reflected accordingly.
- b) The tensile testing method has been refined based on findings of round robin tests, including updated drawings.
- c) A thermal pre-exposure method has been introduced to be equivalent to the thermal effects of a "lamination" cycle. This pre-exposure defines the "fresh" state of the front- or backsheet in final application for evaluation of changes in ageing tests. For practical reasons, an oven exposure has been defined as an equivalent test.

- d) The multiple functions of the lamination protrusion test (previously DTI test) have been clarified, to identify and measure RUI layer thickness as well as to identify layers for which the comparative tracking index (CTI) needs to be determined. Also the content of IEC 62788-2-1 has been updated, by which the lamination protrusion test and MST 04 are additionally set in perspective to each other via engineering judgement.
- e) The DC breakdown voltage test method has been updated and the option to perform a withstand voltage test has been added (to reduce the required measurement voltage). The correction of DC breakdown voltage (V_{BD}) measurements, needed in the presence of non-RUI layers and after the lamination protrusion test, has been defined more precisely.
- f) Details for thickness measurement have been added (engineered surface roughness due to embossing).
- g) The adhesion test methods have been reviewed and updated. The single cantilevered beam test has been added. Figures have been updated to align with IEC 62788-1-1.
- h) The thermal failsafe test has been added as a test method based on discussion in the parallel project for IEC 62788-2-1. The test method offers a single temperature-point evaluation to include elongation at break to the thermal endurance evaluation.
- i) A sequential UV/TC test ("solder bump test") has been added.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
82/2109/DTS	82/2169/RVDTS

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 Technical Specification 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,
- withdrawn,
- replaced by a revised edition, or
- amended.

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MEASUREMENT PROCEDURES FOR MATERIALS USED IN PHOTOVOLTAIC MODULES –

Part 2: Polymeric materials – Frontsheets and backsheets

1 Scope

This part of IEC 62788 defines test methods and datasheet reporting requirements for safety and performance-related properties (mechanical, electrical, thermal, optical, chemical) of non-rigid polymeric materials intended for use in terrestrial photovoltaic modules as polymeric front- and backsheets.

The test methods in this document define how to characterize front- and backsheet materials and their components in a manner representative of how they will be used in the module, which eventually includes combination with other matched components such as encapsulants or adhesives. It is impractical to conduct all characterization and endurance tests for the front- or backsheet component on the module level. Instead, testing is performed directly on these components or on dedicated test coupons prepared under comparable processing conditions (i.e. lamination) as for PV modules.

Results of testing described in this document are called by IEC 62788-2-1 for safety qualification of polymeric front- and backsheets on component level and support the safety and performance-related tests defined on the PV module level as defined in the series IEC 61730 (for safety) and IEC 61215 (for performance). This document also defines test methods for assessing inherent material characteristics of polymeric front- and backsheets or their components, which can be required in datasheet reporting or can be useful in the context of product development or design of PV modules.

Backsheets provide the electrical insulation at the backside of a photovoltaic (PV) module under the environmental stress factors and use conditions encountered during the intended lifetime of the module. Frontsheets have the same function at the sun-facing side of the module. Both can be made from glass or polymeric material.

Polymeric front- and backsheets are typically compositions of layered materials, such as films, adhesives or coatings, in which at least one material layer delivers the relied-upon insulation (RUI) for electrical safety. Other layers can provide extended protection of the RUI against the environmental factors or adhesive functionality. As an integral part of the PV module, the front- or backsheet provides their durable electrical insulating function in the presence of the other components of the PV module, such as solar cells, electrical circuits and connectors, encapsulant, sealing material, and junction boxes. These elements can introduce additional stresses on the front- or backsheet (e.g. by chemical interactions or introducing thermal load or mechanical stress) or alter environmental stresses (e.g. filtering of ultraviolet radiation reaching the sun-facing side of the backsheet).

Material characterization in this document is performed on unaged samples (after a thermal pre-exposure) or after accelerated ageing including thermo-oxidative ageing (thermal endurance and failsafe tests), hydrolytic ageing (damp heat), photolytic ageing (UV weathering), abrasion, and sequential UV ageing plus thermal cycling.

Rigid polymeric sheet materials (also providing mechanical support) can require further consideration, which is outside the scope of this document.

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 60050-581, *International Electrotechnical Vocabulary – Part 581: Electromechanical components for electronic equipment*

IEC 60050-826, *International Electrotechnical Vocabulary – Part 826: Electrical installations*

IEC 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60212, *Standard conditions for use prior to and during the testing of solid electrical insulating materials*

IEC 60216-1, *Electrical insulating materials – Thermal endurance properties – Part 1: Ageing procedures and evaluation of test results*

IEC 60216-2, *Electrical insulating materials – Thermal endurance properties – Part 2: Determination of thermal endurance properties of electrical insulating materials – Choice of test criteria*

IEC 60216-5, *Electrical insulating materials – Thermal endurance properties – Part 5: Determination of relative thermal endurance index (RTE) of an insulating material*

IEC 60243-1, *Electrical strength of insulating materials – Test methods – Part 1: Tests at power frequencies*

IEC 60243-2, *Electric strength of insulating materials – Test methods – Part 2: Additional requirements for tests using direct voltage*

IEC 60296, *Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear*

IEC 60664-1, *Insulation co-ordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60904-3, *Photovoltaic devices – Part 3: Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance data*

IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*

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

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

IEC TS 61836, *Solar photovoltaic energy systems – Terms, definitions and symbols*

IEC 62788-1-4, *Measurement procedures for materials used in photovoltaic modules – Part 1-4: Encapsulants – 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 – Part 1-5: Encapsulants – Measurement of change in linear dimensions of sheet encapsulation material resulting from applied thermal conditions*

IEC 62788-2-1, *Measurement procedures for materials used in photovoltaic modules – Part 2-1 Polymeric materials – frontsheet and backsheet – Safety requirements*

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

IEC TS 62788-6-3, *Measurement procedures for materials used in photovoltaic modules – Part 6-3: Adhesion Testing of Interfaces within PV Modules*

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 62790, *Junction boxes for photovoltaic modules – Safety requirements and tests*

IEC 62805-2, *Method for measuring photovoltaic (PV) glass – Part 2: Measurement of transmittance and reflectance*

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

ISO 527-1, *Plastics – Determination of tensile properties – Part 1: General principles*

ISO 527-3, *Plastics – Determination of tensile properties – Part 3: Test conditions for films and sheets*

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

ISO 1519, *Paints and varnishes – Bend test (cylindrical mandrel)*

ISO 1520, *Paints and varnishes – Cupping test*

ISO 2409, *Paints and varnishes – Cross-cut test*

ISO 2813, *Paints and varnishes – Determination of gloss value at 20 degrees, 60 degrees and 85 degrees*

ISO 4593, *Plastics – Film and sheeting – Determination of thickness by mechanical scanning*

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 11664-1, *Colorimetry – Part 1: CIE standard colorimetric observers*

ISO 11664-2, *Colorimetry – Part 2: CIE standard illuminants*

ISO 11664-4, *Colorimetry – Part 4: CIE 1976 L*a*b* Colour space*

ISO 15105-2, *Plastics – Film and sheeting – Determination of gas-transmission rate – Part 2: Equal-pressure method*

ISO 15106-1, *Plastics – Film and sheeting – Determination of water vapour transmission rate – Part 1: Humidity detection sensor method*

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 17223, *Plastics – Determination of yellowness index and change in yellowness index*

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

ASTM D374, *Standard Test Methods for Thickness of Solid Electrical Insulation*

ASTM D7869, *Standard Practice for Xenon Arc Exposure Test with Enhanced Light and Water Exposure for Transportation Coatings*

UL 746B, *Standard for Polymeric Materials – Long Term Property Evaluations*