

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



**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](https://standards.iteh.ai/catalog/standards/iec/e77579eb-2c38-4f0b-9544-230a7d4de6b0/iec-62788-1-1-2024)

<https://standards.iteh.ai/catalog/standards/iec/e77579eb-2c38-4f0b-9544-230a7d4de6b0/iec-62788-1-1-2024>



**THIS PUBLICATION IS COPYRIGHT PROTECTED**  
**Copyright © 2024 IEC, Geneva, Switzerland**

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Secretariat  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

#### About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

#### About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

#### IEC publications search - [webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

#### IEC Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [sales@iec.ch](mailto:sales@iec.ch).

#### IEC Products & Services Portal - [products.iec.ch](http://products.iec.ch)

Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

---

#### A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

#### A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

#### Recherche de publications IEC -

#### [webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

#### Service Clients - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: [sales@iec.ch](mailto:sales@iec.ch).

#### IEC Products & Services Portal - [products.iec.ch](http://products.iec.ch)

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications, symboles graphiques et le glossaire. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 500 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 25 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



**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](https://standards.iteh.ai/standards/iec/62788-1-1/2024)

<https://standards.iteh.ai/catalog/standards/iec/e77579eb-2c38-4f0b-9544-230a7d4de6b0/iec-62788-1-1-2024>

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

ICS 27.160

ISBN 978-2-8322-9040-8

**Warning! Make sure that you obtained this publication from an authorized distributor.  
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

## CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references .....	6
3 Terms and definitions .....	9
4 Principle.....	11
5 Test methods.....	14
5.1 General.....	14
5.2 Optical.....	14
5.2.1 Optical: transmittance and UV cut-off wavelength.....	14
5.2.2 Optical: durability of transmittance.....	15
5.2.3 Optical: index of refraction.....	15
5.3 Mechanical .....	16
5.3.1 Mechanical: linear dimension (width).....	16
5.3.2 Mechanical: area weight.....	17
5.3.3 Mechanical: ideal planar thickness .....	18
5.3.4 Mechanical: storage modulus and loss factor.....	19
5.3.5 Mechanical: hardness.....	20
5.3.6 Mechanical: coefficient of linear thermal expansion (CTE).....	21
5.3.7 Mechanical: adhesion.....	22
5.3.8 Mechanical: durability of adhesion.....	27
5.3.9 Mechanical: phase transition and glass transition temperatures.....	28
5.3.10 Mechanical: EVA degree of cure (DoC).....	29
5.3.11 Mechanical: change in linear dimension (CiLD).....	30
5.3.12 Mechanical: blocking load.....	31
5.4 Electrical.....	32
5.4.1 Electrical: volumetric resistivity.....	32
5.4.2 Electrical: comparative tracking index (CTI).....	33
5.5 Thermal .....	33
5.5.1 Thermal: conductivity.....	33
5.5.2 Thermal: decomposition temperature (TDT).....	34
5.6 Chemical .....	35
5.6.1 Chemical: water vapour transmission rate .....	35
5.6.2 Chemical: water absorption .....	36
5.7 Ignition and flammability .....	36
5.8 Accelerated ageing tests.....	36
6 Uniform characterization form (UCF) .....	37
6.1 General.....	37
6.2 Details of the UCF .....	37
6.3 Reporting requirements.....	40
7 Datasheet reporting.....	40
7.1 General.....	40
7.2 Purpose .....	40
7.3 Details of the datasheet .....	40
7.4 Reporting requirements.....	41
8 Product identification sheet (label).....	42
9 Documentation and testing for similar materials.....	42

9.1	Model and variant designation .....	42
9.2	General.....	42
9.3	Alternate constituent materials, lamination, and manufacture .....	43
9.4	Alternate thickness or surface texture .....	44
9.5	Colour variants .....	44
9.6	Allowed distinction in performance and durability and treatment of the results .....	44
9.7	Reporting .....	46
10	Test report.....	46
Annex A (informative)	Durability of encapsulant adhesion .....	47
A.1	General.....	47
A.2	Reference documents – accelerated ageing/durability of encapsulant adhesion .....	47
Annex B (informative)	The single cantilever beam adhesion test method .....	49
B.1	General.....	49
B.2	Reference documents – the SCB adhesion test method .....	49
Annex C (informative)	The composition quality ratio (CQR) test method .....	50
C.1	General.....	50
C.2	Composition quality ratio (CQR).....	50
C.3	Sampling .....	50
C.4	Apparatus .....	51
C.5	Procedure .....	51
C.6	Reporting .....	53
Bibliography	.....	54
Figure 1	– Schematic showing the specimens and implementation of the peel test, in cross-section and from the side, including a) backsheet/encapsulant interface, b) encapsulant/glass interface, c) encapsulant cell interface, and d) encapsulant-1/encapsulant-2 interface.....	23
Figure 2	– Schematic showing the geometry of the specimens within a laminated coupon for the backsheet/encapsulant interface.....	24
Figure 3	– Schematic showing example data profiles for the 180° peel test.....	26
Figure 4	– Flow chart for the evaluation of an alternate encapsulant relative to an incumbent encapsulant in IEC 62788-1-1 .....	45
Figure C.1	– Schematic identifying the location of specimens within a sample set.....	51
Figure C.2	– Example TGA measurement for 28 % VAc EVA, obtained using nitrogen purge gas (specimen and balance) .....	53
Table 1	– General summary of encapsulant characteristics and their use in the universal characterization form, datasheet reporting, process and manufacturing control, and weathering.....	12
Table 2	– Representative density values for common PV encapsulants.....	19
Table 3	– Details of the uniform characterization form (UCF) for polymeric PV encapsulants .....	38
Table 4	– Minimum required characteristics for the datasheet.....	41

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## MEASUREMENT PROCEDURES FOR MATERIALS USED IN PHOTOVOLTAIC MODULES –

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

#### FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

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](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/publications](http://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](http://webstore.iec.ch) in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

**IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.**

iTeh Standards  
(<https://standards.iteh.ai>)  
Document Preview

[IEC 62788-1-1:2024](#)

<https://standards.iteh.ai/catalog/standards/iec/e77579eb-2c38-4f0b-9544-230a7d4de6b0/iec-62788-1-1-2024>



# 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]

## 4 Principle

For compliance with this document, the following test procedures shall be used to assess the optical, mechanical, electrical, thermal, and chemical characteristics of polymeric materials intended for use in terrestrial PV modules as polymeric encapsulants.

The universal characterization form (UCF) provides standardized comprehensive reporting of characteristics often considered for encapsulants, including those found in the datasheet. For the purpose of the UCF, characteristics marked in Table 1 with a ("✓") are required. The UCF and its requirements are described in Clause 6.

For the purpose of datasheet reporting, characteristics marked in Table 1 with a ("✓") are required to be characterized using the methods described in this standard. Additional optional characteristics that may be helpful for the use of encapsulants in PV technology are identified in Table 1 with an ("O").

Characteristics that are most frequently used for the purposes of process or manufacturing control are identified in Table 1 with a ("✓"). Additional characteristics that may also be reported for PV encapsulants are identified in Table 1 with an ("O"). At present, the use of these methods is considered an optional test. The methods identified here as required or optional are intended to aid in the use of IEC 62941. The use of characteristics for process or manufacturing control is not required in this document. Rather, those characteristics that are identified by manufacturers to fulfil IEC 62941 shall be considered a required test; any additional characteristics shall be considered an optional test.

Some characteristics are more readily affected by weathering. Critical characteristics that shall be examined in conjunction with accelerated ageing are identified in Table 1 of this document with a ("✓"). The examination of optical transmittance and UV cut-off wavelength for the weathering of encapsulant according to IEC 62788-1-7 (if it impacts power generation), as well as the durability of encapsulant adhesion to accelerated testing, is required for this document; the results of the test shall be reported in the encapsulant datasheet.

[IEC 62788-1-1:2024](https://standards.iteh.ai/catalog/standards/iec/e77579eb-2c38-4f0b-9544-230a7d4de6b0/iec-62788-1-1-2024)

<https://standards.iteh.ai/catalog/standards/iec/e77579eb-2c38-4f0b-9544-230a7d4de6b0/iec-62788-1-1-2024>

**Table 1 – General summary of encapsulant characteristics and their use in the universal characterization form, datasheet reporting, process and manufacturing control, and weathering**

Type	Characteristic	Subclause	Reference	Universal characterization form (UCF)	Datasheet reporting	Process and manufacturing control	Weathering
Optical fit Impacts power generation	Transmittance and UV cut-off wavelength	5.2.1	IEC 62788-1-4	✓	✓		
	Durability of transmittance	5.2.2	IEC 62788-1-7	✓	✓		✓
	Index of refraction	5.2.3	ISO 489	✓	0		
Mechanical	Linear dimension (width)	5.3.1	IEC 62788-1-1	✓	0	0	
	Areal weight	5.3.2	ISO 536	✓	0		
	Ideal planar thickness	5.3.3	ISO 1183-1; ISO 1183-2	✓	0	0	
	Storage modulus and loss factor	5.3.4	ISO 6721-1; ISO 6721-4	✓	✓		
	Hardness	5.3.5	ISO 48-4; ISO 48-9	✓	0		
	Coefficient of linear thermal expansion (CTE)	5.3.6	ISO 11359-2	✓	0		
	Adhesion (encapsulant/glass), (encapsulant/cell)	5.3.7	ISO 8510-2; IEC TS 62788-6-3	✓	✓	0	
	Adhesion (backsheet/encapsulant), (encapsulant-1/encapsulant-2)	5.3.7	ISO 8510-2; IEC TS 62788-6-3	0	0	0	
	Durability of adhesion (encapsulant/glass) (encapsulant/cell)	5.3.8		✓	✓		✓
	Durability of adhesion (backsheet/encapsulant), (encapsulant-1/encapsulant-2)	5.3.8		0	0		0
	Phase transition and glass transition temperatures	5.3.9	ISO 11357-1; ISO 11357-2; ISO 11357-3	✓	0		
	EVA degree of cure (DoC)	5.3.10	IEC 62788-1-6	✓		✓	
Change in linear dimension (CiLD)	5.3.11	IEC 62788-1-5	✓	✓	✓		
Blocking load	5.3.12	ISO 11502	✓	0			