FINAL
DRAFT

INTERNATIONAL
STANDARD

**ISO/FDIS
23237**

ISO/TC **160**

Secretariat: **BSI**

Voting begins on:
2023-08-22

Voting terminates on:
2023-10-17

Glass in building – Laminated solar photovoltaic glass for use in buildings – Light transmittance measurement method

Reference number
ISO/FDIS 23237:2023(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO 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, ISO *[had/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 www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 160, *Glass in building*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Glass in building – Laminated solar photovoltaic glass for use in buildings – Light transmittance measurement method

1 Scope

This document specifies a test method of light transmittance for the laminated solar photovoltaic glass for use in building.

This document is applicable to flat modules with light transmittance in the visible range (wavelengths from 380 nm to 780 nm).

This document does not cover the assessment method of total solar energy transmittance of the flat module.

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.

ISO 9050:2003, *Glass in building — Determination of light transmittance, solar direct transmittance, total solar energy transmittance, ultraviolet transmittance and related glazing factors*

CIE 130, *Practical Methods for the Measurement of Reflectance and Transmittance*

3 Terms and definitions

For the purposes of this document, the terms and definitions and symbols of ISO 9050 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
laminated solar photovoltaic glass for use in building
photovoltaic panel which contains at least one piece of glass and fulfils the requirement for building application

3.2
cover glass
glass on the sun facing side of a *laminated solar photovoltaic glass for use in building* (3.1)

3.3
back glass/sheet
glass/sheet on the away from sun facing side of a *laminated solar photovoltaic glass for use in building* (3.1)

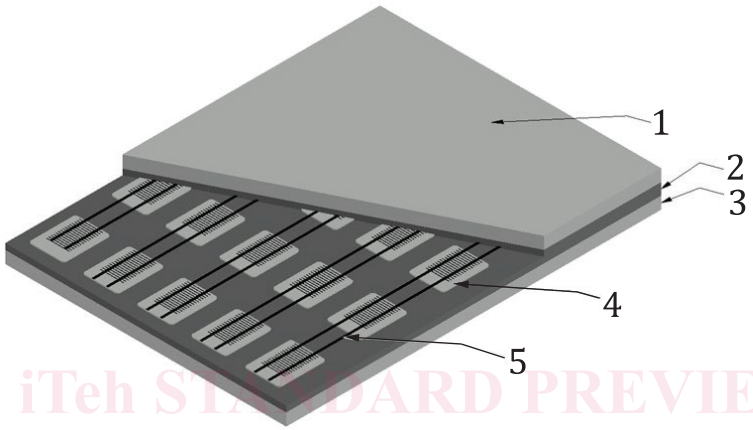
3.4
substrate structure
thin film photovoltaic cells formed on the *back glass/sheet* (3.3) (below the encapsulation foil)

3.5
superstrate structure
thin film photovoltaic cells formed on the *cover glass* (3.2) (above the encapsulation foil)

4 Types of laminated solar photovoltaic glass for use in building

According to the different ways it can be made transparent, the laminated solar photovoltaic glass for use in building can be divided into three categories.

a) Type A: The laminated solar photovoltaic glass consists of lots of single solar cells with a gap, as shown in Figure 1;

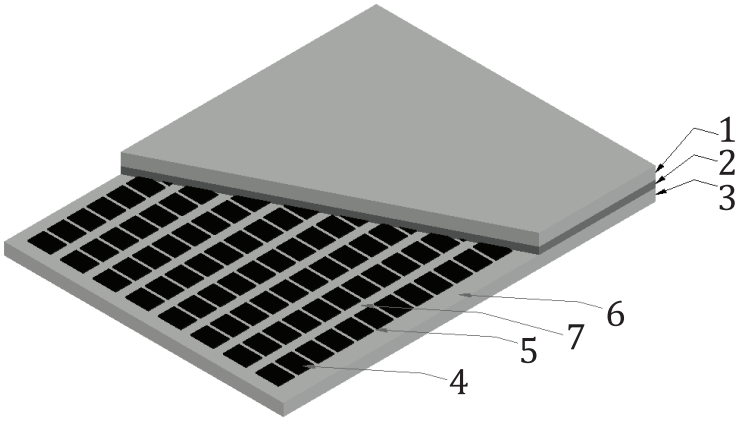


Key
1 cover glass
2 encapsulation foil
3 back glass/sheet
4 solar cell
5 busbar

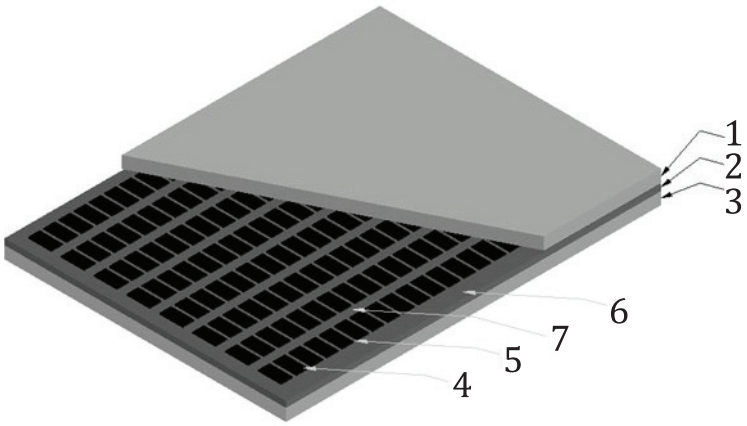
Figure 1 — Structure of the module containing of lots of single cells with gap

b) Type B: Part of solar cells in the module is etched away by laser or mechanical procedure.

In this kind of module, the solar cells are not transparent and some area of solar cells is etched away by laser or mechanical procedure so the module is partially transparent, as shown in Figure 2. The etched area can be strips or any other shape.



a) Substrate structure



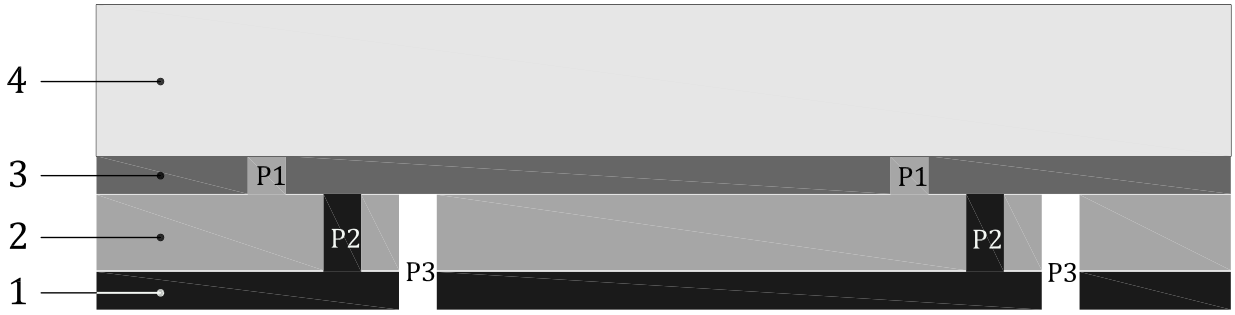
b) Superstrate structure

Key

1 cover glass
2 encapsulation foil
3 back glass/sheet
4 thin film solar cell
5 interconnection lines
6 edge deleted area
7 ablated transparent area

Figure 2 — Structure of the thin film photovoltaic (PV) module in a building

Figure 3 is structure of a unlaminated PV panel with the superstrate structure via the monolithic series interconnection which is processed by three scribing processes P1, P2 and P3, either by laser or needle. The transparent conducting oxide is scribed by P1, followed a P2 process to remove the absorber and a P3 process to remove both the absorber and the back contact or only remove the back contact. In this former case, the light can pass through glass and transparent conducting oxide via p3 scribing line, which contributes to the light transmittance of the module.



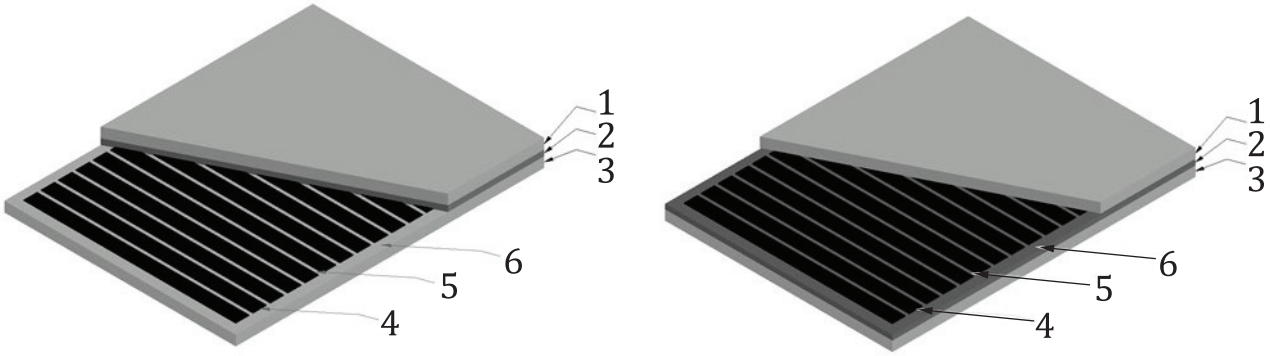
Key

1 back contact
2 absorber
3 transparent conducting oxide
4 glass

Figure 3 — Structure of an unlaminated PV panel with the superstrate structure via the monolithic series interconnection

c) Type C: The module contains semi-transparent solar cells.

In this kind of module, the solar cells are semi-transparent, as shown in Figure 4.



a) Substrate structure **b) Superstrate structure**

Key

1 cover glass
2 encapsulation foil
3 back glass/sheet
4 semi-transparent thin film solar cell
5 interconnection lines
6 edge deleted area

Figure 4 — Structure of the semi-transparent thin film PV module

5 Conditions and performance of optical measurements

The testing environment and instrument shall be as follows:

— wavelength range: from 380 nm to 780 nm;

— wavelength interval: 5 nm;

— wavelength accuracy: ±0,5 nm.

The photometric accuracy should be less than 1 % and the photometric precision should be less than 0, 5 %.

Measurement shall be performed in accordance with ISO 9050:2003, 3.1 and 3.2.

NOTE A 150 mm integrating sphere can be insufficient for this purpose.

6 Specimen

6.1 Specimen general requirements

No dust, oil contamination or other pollutants shall be on the surface of the specimen.

The specimen should not contain defects which can affect the performance of the material or cause a deviation from the study result.

When the glass used in the module is to be thermally treated, in spectrophotometric measurement, it can be substituted with annealed glass, provided that glass product is identical.

The specimen to be taken for the measurement of light transmittance of the transparent area of the laminated solar photovoltaic glass for use in building shall be as follows.

— For the module type A:

  — Materials: Cover glass, back glass/sheet and encapsulation foil.

  — Process: The cover glass and the back sheet shall be laminated with the same process of the module lamination process.

— For the module type B:

  — Materials: The same materials which are used to manufacture the module.

    Edge sealing material and junction box are not needed.

  — Specimen where the light can be transmitted via P3 scribing lines (as shown in Figure 3): The same process as the module manufacturing process shall be applied. The back contact and absorber layer shall be scribed by the same process as in the module manufacturing process, i.e. either by laser or mechanical procedure. The transparent conducting oxide shall remain intact.

— For the module type C:

  — Materials: The same materials which are used to manufacture the module. Edge sealing material and junction box are not needed.

  — Process: The same process as the module manufacturing process shall be applied.

6.2 Specimen size and shape

The specimen size of the module for the measurement of light transmittance of the transparent area of the laminated solar photovoltaic glass for use in building should be large enough to cover the entrance window of the integrating sphere.

6.3 Specimen quantity

For measurement of the transparent part, one specimen is sufficient.

For measurement of PV product of a homogenous colour and surface, one specimen is sufficient.

Three specimens are required for PV products with inhomogeneous colour and surface.

6.4 Standard sample

The air layer shall be used as a reference standard sample.

7 Measurement of light transmittance of the transparent area of the laminated solar photovoltaic glass used in buildings, $\tau_0(\lambda)$

Each of the three specimens shall be measured with the cover glass directed towards the integrating sphere. Measurement shall be done in accordance with CIE 130.

Calculate the light transmittance of each specimen according to ISO 9050:2003, Formula (1).

The value τ_0 is the average of the light transmittance of the three specimens.

The same procedure shall be repeated for the other type(s) of transparent and/or semi-transparent area, if any.

8 Light transmittance of the laminated solar photovoltaic glass for use in building, τ

The total area of the module S and the total transparent area of the module S_1 are measured by using a length measurement tool or digital image processing. The ratio of the area of the transparent part to the total area of the module η is calculated according to Formula (1).

$$\eta = \frac{S_1}{S} \times 100\,\% \tag{1}$$

The light transmittance of the module τ is calculated according to Formula (2), in the cases where there is only one type of transparent or semi-transparent area.

$$\tau = \tau_0 \times \eta \tag{2}$$

In case there are at least two transparent and/or semi-transparent areas, for example in cases described in Figures 3 and 4, the light transmittance of the different transparent parts shall be calculated separately using the procedure described in Clause 7 and this clause.

The light transmittance of PV module is the sum of the weighted light transmittance of the different transparent parts, each of them being calculated according to Formula (2).

9 Test report

The test report shall include at least the following:

a) test results;

b) identification of the sample;

c) type of PV;

d) identification of the manufacturer;

e) the International Standard used (including its year of publication);

f) the method used (if the standard includes several);

g) criteria used;

h) size and thickness of specimen;

i) test instrument;

j) any deviations from the procedure;

k) any unusual features observed;

l) date of the measurement.