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

Verre dans la construction — Verre feuilleté photovoltaïque pour utilisation dans les bâtiments — Méthode de mesure de la transmission lumineuse

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Foreword

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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)

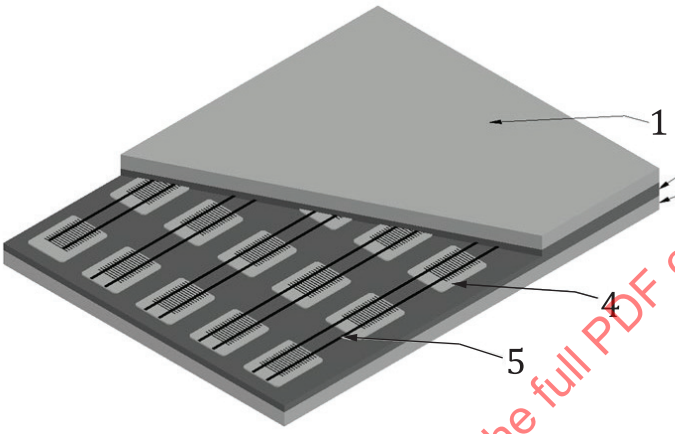
3.4
substrate structure
thin film photovoltaic cells formed on the *back glass/sheet* (3.3) (below the encapsulation foil)

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 (PV) 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.

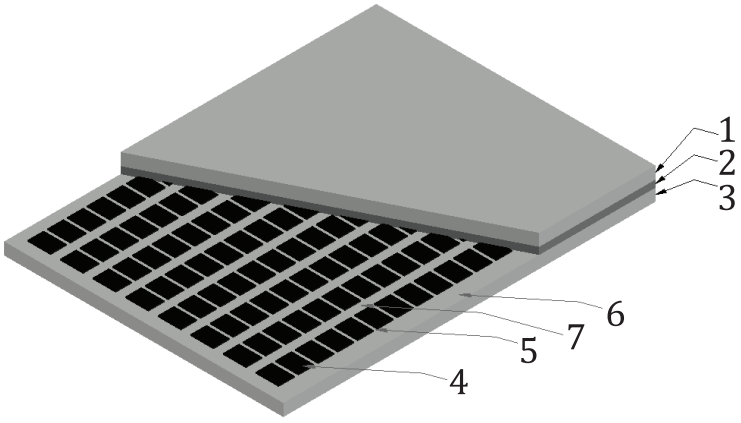


Key
1 cover glass
2 encapsulation foil
3 back glass/sheet
4 solar cell
5 busbar

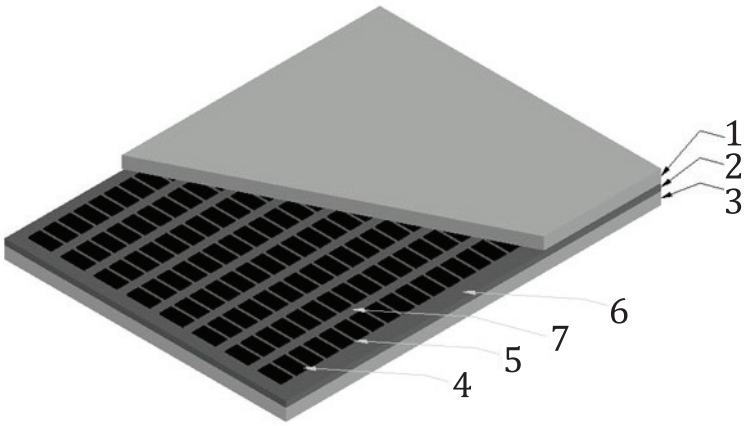
Figure 1 — Structure of the module containing of lots of single cells with gap

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



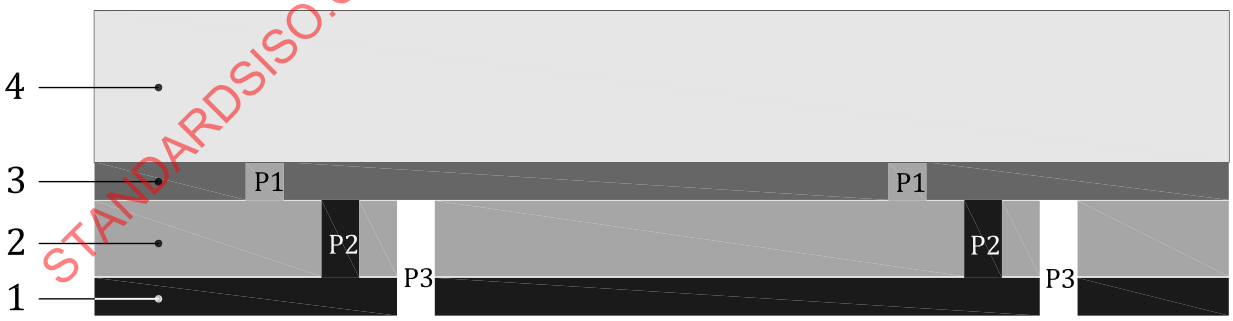
b) Superstrate structure

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 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.



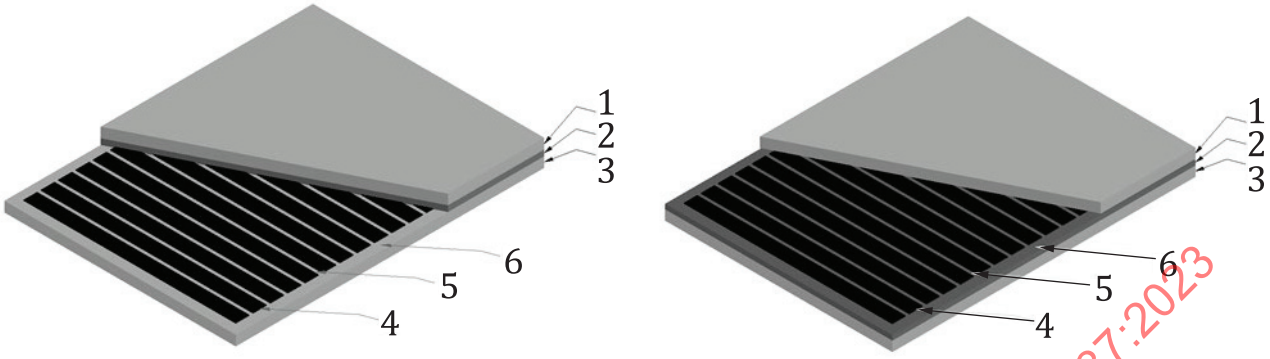
Key

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 materials are 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 in accordance with ISO 9050:2003, Formula (1).

The value τ 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.