International Standard

ISO 11983

Road vehicles — Safety glazing materials — Test methods for electro-switchable glazing

Véhicules routiers — Vitrages de sécurité — Méthodes d'essai pour vitrages électro-commutables

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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

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Foreword

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This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 35, *Lighting and visibility*.

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.

Introduction

This document outlines the test method to evaluate properties of electro-switchable glazing during the switching period and under stable states of luminous transmittance.

There are various principles of electro-switchable glazing that can be used to produce safety glazing for road vehicles. See Annex A for a description of these principles. The luminous transmittance states that the electro-switchable glazing can be switched to and the time it takes to switch between these states are major concerns for consumers and the market. The lifetime of these different electro-switchable glazing is influenced by humidity, temperature and radiation. The various principles differ in terms of performance, but they can be improved applying appropriate voltage or current or applying more complex circuits.

Road vehicles — Safety glazing materials — Test methods for electro-switchable glazing

1 Scope

This document provides the test methods for regular luminous transmittance, switching time, haze, insulation resistance, humidity resistance, low temperature resistance, colour uniformity, switching cycles and radiation durability for electro-switchable glazing used on road vehicles.

This document applies to switchable glazing in response to applied voltage or current.

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 3538:1997, *Road vehicles — Safety glazing materials — Test methods for optical properties*

ISO 4892-2:2013, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

ISO 6469-3:2021, *Electrically propelled road vehicles — Safety specifications — Part 3: Electrical safety*

ISO/CIE 11664-6, *Colorimetry — Part 6: CIEDE2000 colour-difference formula*

ISO 13837:2021, *Road vehicles — Safety glazing materials — Method for the determination of solar transmittance*

ISO 14782:2021, *Plastics — Determination of haze for transparent materials*

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:

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

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

3.1
electro-switchable glazing
glazing comprised of one or more panes of material whose transmittance properties can be altered in response to an applied voltage or current

3.2
highest transmittance state
stable state as glazing switched to highest *regular luminous transmittance* (3.4) under specific conditions

Note 1 to entry: This is also referred to as the clear state or bleached state.

3.3
lowest transmittance state
stable state as glazing switched to lowest *regular luminous transmittance* (3.4) under specific conditions

Note 1 to entry: This is also referred to as the tinted state, dark state, or coloured state.

3.4
regular luminous transmittance
light transmittance from 380 nm to 780 nm measured perpendicularly to the glazing without considering diffused light

3.5
tinting time
period of *electro-switchable glazing* (3.1) switching from *highest transmittance state* (3.2) to *lowest transmittance state* (3.3)

3.6
switching cycle
electro-switchable glazing (3.1) switched from lowest/*highest transmittance state* (3.2) to highest/*lowest transmittance state* (3.3) and back to lowest/highest transmittance state with each process finished once

4 Test methods

4.1 Ambient conditions

Unless otherwise specified, the tests shall be conducted under the following conditions:

a) ambient temperature: (23 ± 5) °C;

b) atmospheric pressure: $8{,}06 \times 10^4$ Pa to $1{,}06 \times 10^5$ Pa (860 mbar to 1 060 mbar);

c) relative humidity:(60 ± 20) %.

4.2 Regular luminous transmittance

4.2.1 Purpose of test

The purpose of this test is to determine regular luminous transmittance of electro-switchable glazing in different transmittance states.

4.2.2 Apparatus

4.2.2.1 Control system, which shall be provided by the manufacturers for switching the device under test (DUT) to a different state. The control system and parameters shall be pre-set to make the specimen switch same as finished product.

4.2.2.2 Regular luminous transmittance measuring system, which is described in ISO 3538:1997, 5.1.2.

4.2.3 Measuring state

The regular luminous transmittance of any state that the glazing can be switched to, may be measured.

4.2.4 Device under test

One specimen or finished product may be used as the DUT.

4.2.5 Procedure

Before measuring regular luminous transmittance, switch the DUT for at least five cycles.

Then, switch the whole DUT to required state and keep it in that state for about 5 min. Measure regular luminous transmittance of the DUT according to ISO 3538:1997, 5.1.3.

4.2.6 Expression of results

Record the regular luminous transmittance and the corresponding state of DUT. The value shall be rounded to 0,1 %.

4.3 Switching time

4.3.1 Purpose of test

The purpose of this test is to determine the switching time between different states of electro-switchable glazing.

4.3.2 Apparatus

4.3.2.1 Spectrophotometer, which has the time drive function and whose time interval can be switched to 1 s or shorter. An equivalent photometer can be used, but the light output shall be filtered to 550 nm ± 5 nm or other required wavelengths, and the measurements shall be recorded per second or shorter.

4.3.2.2 Control system, which shall be provided by the manufacturers for switching the DUT to a different state. The control system and parameters shall be pre-set to make the specimen switch same as finished product.

4.3.3 Device under test

One specimen or finished product may be used as the DUT. When a specimen is used, the shape of the specimen shall be able to cover a square whose sides are 290 mm in length.

4.3.4 Procedure

4.3.4.1 Use the time drive function of the spectrophotometer to measure light transmittance at 550 nm ± 5 nm or other required wavelengths when measuring switching time.

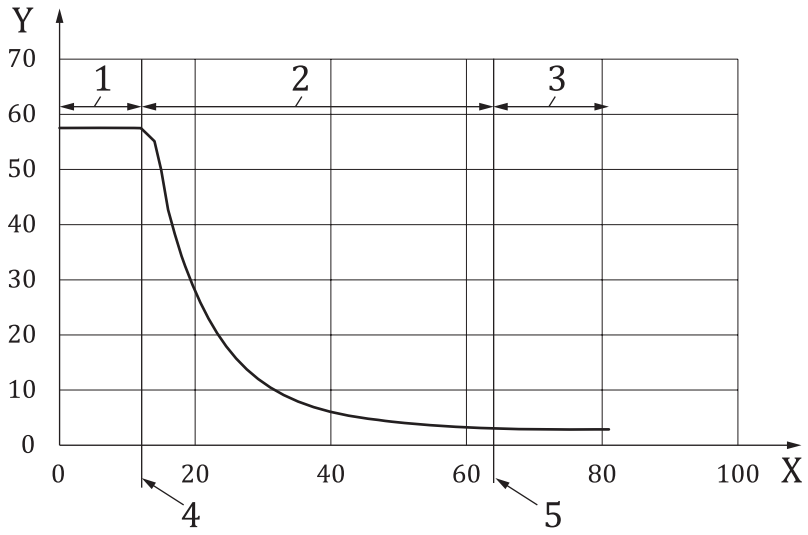
4.3.4.2 Keep the whole DUT in the bleached state for at least 5 min. Then, switch the DUT to the tinted state. Record light transmittance at 550 nm ± 5 nm during the whole switching period. When the entire DUT reaches the tinted state, record for at least 30 s if the switching time is more than 10 s, or record for at least 10 s if the switching time is less than 10 s. See Figure 1 for an example of electro-switchable glazing with a tinting time of more than 10 s. See Figure 2 for an example of electro-switchable glazing with a tinting time of less than 10 s.

4.3.4.3 Keep the whole DUT at the tinted state for at least 5 min. Then, switch the DUT from the tinted state to the bleached state, record the data same as 4.3.4.2.

4.3.4.4 The moment the tinted or bleached state is reached shall be defined between the customer and manufacturer. The following are two example methods for defining the moment the tinted or bleached state is reached:

a) for a switching time of more than 10 s: when variation in light transmittance at 550 nm ± 5 nm in the next 10 s is smaller than 0,1 %;

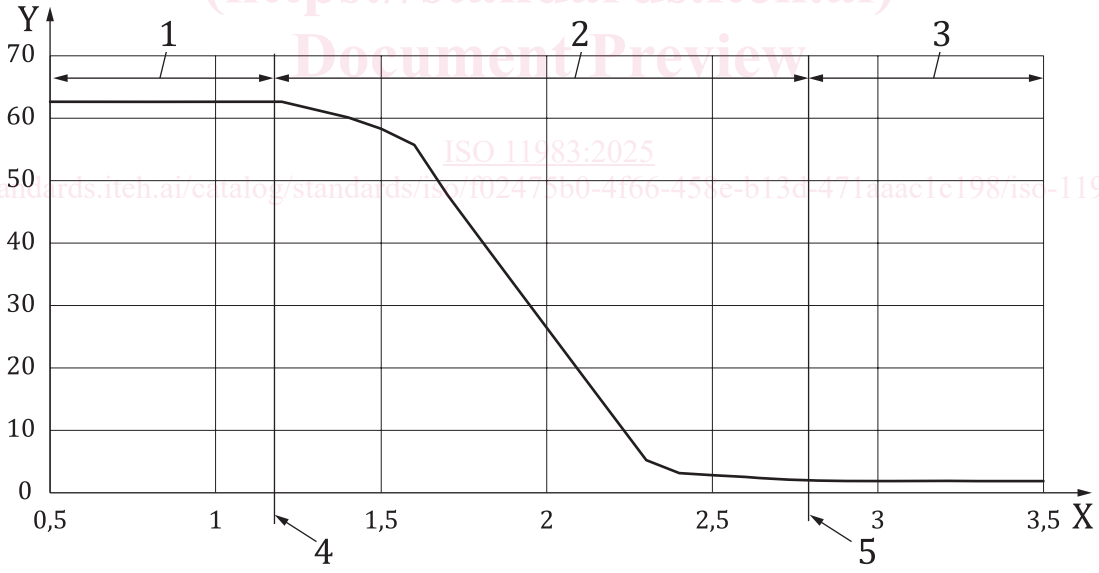
b) for a switching time of less than 10 s: when variation in light transmittance at 550 nm ± 5 nm in the next 1 s is smaller than 0,1 %.



Key

X	time [s]	3	tinted state
Y	550 nm light transmittance [%]	4	switching start moment
1	bleached state	5	switching stop moment
2	tinting time		

Figure 1 — Example for tinting time more than 10 s



Key

X	time [s]	3	tinted state
Y	550 nm light transmittance [%]	4	switching start moment
1	bleached state	5	switching stop moment
2	tinting time		

Figure 2 — Example for tinting time less than 10 s