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Glass in building — Electrochromic glazings — Accelerated ageing test and requirements

Verre dans la construction — Vitrages électrochromes — Essai de vieillissement accéléré et exigences

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Foreword

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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 documents 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).

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For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 160, *Glass in building*, Subcommittee SC 1, *Product considerations*.

Introduction

Electrochromic (EC) glazings perform several important functions in a building envelope, including

— minimizing the solar energy heat gain,

— providing for passive solar energy gain,

— controlling a variable visual connection with the outside world,

— enhancing thermal comfort (controlling heat gain), energy efficiency performance, illumination, and glare control, and

— providing for architectural expression.

Therefore, it is important to understand the relative serviceability of these glazings.

This document is intended to provide a means for evaluating the durability of electrochromic glazings.

The test procedures covered in this document includes:

a) rapid but realistic cycling between high and low light transmission states;

b) environmental parameters that are typically used in weatherability tests such as simulated solar exposure and high temperature, which are realistic for the intended use of electrochromic glazings.

Glass in building — Electrochromic glazings — Accelerated ageing test and requirements

1 Scope

This document specifies the accelerated ageing test and requirements for electrochromic (EC) glazings.

The test method described in this document is only applicable to chromogenic glazings that can be switched using an electrical stimulus from high to low transmission states and vice versa. This test method is not applicable to other chromogenic glazings such as photochromic and thermochromic glazings, which do not respond to electrical stimulus.

This test method is applicable to any electrochromic glazing fabricated for vision glass (e.g. insulating glass unit, laminated glass) for use in buildings such as doors, windows, skylights and exterior wall systems and glazing exposed to solar radiation. The layers used for constructing the EC glazing and for electrochromically changing the optical properties can be inorganic or organic materials.

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*

ISO 12543 (all parts), *Glass in building — Laminated glass and laminated safety glass*

ISO 20492 (all parts), *Glass in buildings — Insulating glass*

3 Terms and definitions

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

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

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

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

3.1
chromogenic glazing
glazing that has the ability to change its visible and/or solar transmittance in response to an external stimulus such as electrical voltage or current, sunlight or temperature

3.2
electrochromic
EC
combination of materials through which visible and/or solar transmittance characteristics can be altered in response to an applied voltage or current

3.3
electrochromic glazing
EC glazing
glazing comprised of one or more panes of glass containing materials with *electrochromic* (3.2) properties

3.4
highest transmittance state
electrochromic glazing (3.3) when it is in the transmission state with the highest visible light transmittance

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

3.5
lowest transmittance state
electrochromic glazing (3.3) when it is in the transmission state with the lowest visible light transmittance

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

3.6
lateral uniformity
degree of variation in the amount of irradiance in the x and y directions in the test plane used for exposing *electrochromic glazing* (3.3)

3.7
switching time
time it takes for *electrochromic glazing* (3.3) to transition from one transmittance state to another

Note 1 to entry: The time to go from a lower transmittance state to a higher transmittance state can be different from the time needed for the reverse transition.

3.8
switching cycle
transition in light transmittance through the whole or part of the *electrochromic glazing's* (3.3) visible light transmittance range starting at one end of the range (at τ_H or τ_L) and ending back at the same point

4 Symbols and abbreviated terms

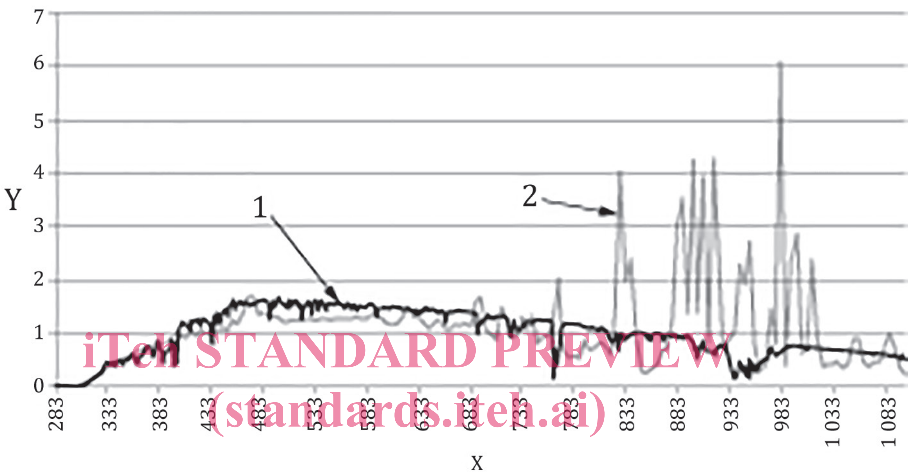
EC	electrochromic
IGU	insulating glass unit(s)
NIR	near infrared (radiation)
PTR	photopic transmittance ratio
T	transmission
$\tau_{H,i}$	visible light transmittance[a] in the highest transmission state prior to accelerated ageing
$\tau_{L,i}$	visible light transmittance[a] in the lowest transmission state prior to accelerated ageing
$\tau_{H,f}$	visible light transmittance[a] in the highest transmission state after accelerated ageing
$\tau_{L,f}$	visible light transmittance[a] in the lowest transmission state after to accelerated ageing
t_L	time during which the transmittance of the glazing is reducing
t_H	time during which the transmittance of the glazing is increasing

t_{cycle}	total cycle time; the sum of t_L and t_H.
UV	ultraviolet (radiation)

[a] See ISO 9050.

5 Test equipment

5.1 Test chamber, temperature-controlled and contains xenon arc lamps that have been filtered appropriately in order to simulate the spectral power distribution of solar radiation over the ultraviolet (UV), visible and near infrared (NIR) wavelength regions. Figure 1 shows the spectral irradiance of an appropriately filtered xenon arc source compared to the global AM 1,5 spectrum.



Key

X wavelength of the radiation in nm

Y irradiance in $W/m^2/nm$

1 spectral power distribution of AM 1,5 solar irradiation

2 irradiance of an appropriately filtered xenon arc lamp which is used to simulate the spectral power distribution of solar radiation

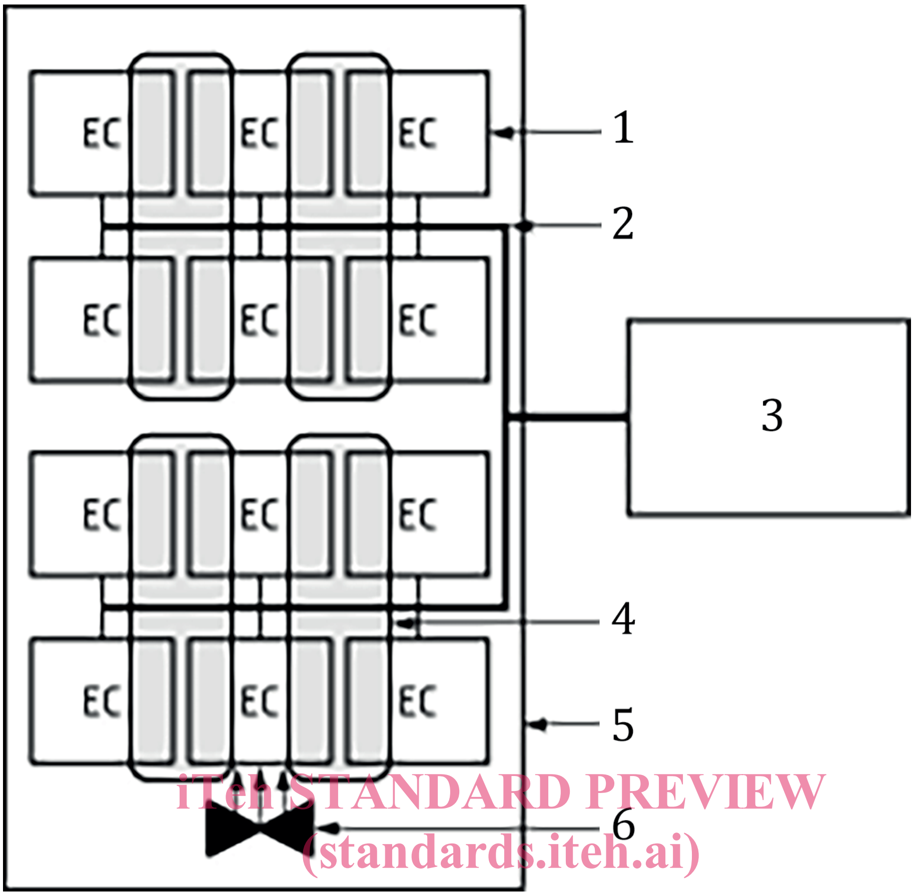
Figure 1 — Irradiance of an appropriately filtered xenon arc lamp compared to the spectral power distribution of AM 1,5 solar irradiation

NOTE 1 At longer wavelengths, the xenon arc emission is at variance with the air mass 1,5 solar spectrum because the intensities relative to those in the UV/visible region are higher than in solar radiation. However, this part of the spectrum does not cause photolytic-induced degradation.

Figure 2 shows an example top-view of the essential features of the test chamber, including the layout of the EC glazings on a test plane, the location of the xenon arc lamps above the test plane and the necessary connecting cables from the EC glazings to the computer-controlled cycling and data acquisition system. Chamber dimension shall be large enough to accommodate all specimens.

The intensity of the irradiance at the specimens shall be adjustable to obtain the desired light intensity and lateral uniformity within the guidelines of this document.

NOTE 2 This can be achieved by adjusting the distance between the specimens and the lamps.



Key

1 EC glazings
2 electrical leads and thermocouples
3 EC cycling unit and data acquisition system
4 lamp sources
5 chamber enclosure
6 forced-air heating/cooling system

Figure 2 — Example top-view of the essential features of the environmental test chamber

Temperature control within the test chamber shall be provided. Conditions inside the closed space shall be controlled for air temperatures from 20 °C to 95 °C. The relative humidity within the test chamber shall not exceed 60 %.

Simulated solar irradiance shall be provided by the appropriate number of spectrally filtered and water-cooled 6 500 W, long-arc xenon arc lamps housed within a reflector system in the ceiling of the test chamber. The lamps shall be suitably filtered to provide a match of an air mass 1,5 solar spectrum from 300 nm to 900 nm (see Figure 1). The water-cooled lamps shall be surrounded by an NIR-absorbing filter, which reduces the heat load. The chamber shall be designed to achieve a radiation intensity over the spectral range of 300 nm to 3 000 nm of (1 000 ± 40) W/m^2 at the specimens. The lateral uniformity of irradiance across the test plane shall be no more than ±8 %. The EC glazing specimens shall be located on the test plane beneath the xenon arc lamps. The test chamber shall have a means for allowing electrical connections to pass from inside to outside the unit to allow temperature monitoring and electrical control of the EC glazings.

NOTE 3 A suitable lamp source and filter combination is a 3 500 W/6 500 W xenon burner (part number 20-6500-00) with an inner quartz filter (part number 20650600 and an outer filter of CIRA/Sodalime (Part Number 2065200) from Atlas®[1)].

1) CIRA and Sodalime are trade names of a product supplied by Atlas. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

Thermocouples shall be used to measure specimen and chamber temperatures in the test chamber and the oven.

5.2 Electrochromic (EC) cycling unit, imposes voltage and/or current cycles to alternately and repeatedly change the transmittance of the EC glazings while in the test chamber.

NOTE The EC cycling unit can be provided by the EC glazing manufacturer.

5.3 Spectrometer, used for obtaining and storing data from the optical characterization in the range 380 nm to 780 nm of the specimens in the highest and lowest transmission states.

5.3.1 Spectrometer lamp source, tungsten lamp or other lamp source that provides illumination from 380 nm to 780 nm.

5.3.2 Spectrometer fibre optic cables, routed from the lamp source into the EC glazing specimen holder and from the EC glazing specimen holder to the spectrometer. One optical fibre guides the incident light from the lamp source to one side of the specimen; another optical fibre guides the transmitted light to the spectrometer attached to a computer. The fibres shall be optically coupled by properly aligned collimating lens assemblies attached to both the illuminating and the collection fibres.

5.4 Switching control system, switching to and from highest and lowest transmission states during spectrophotometer transmittance measurements can be done by means of a computer controlled multichannel potentiostat or by manufacturer supplied control system.

5.5 Oven, capable of heating the test specimens to the selected test temperature (see Figure 3). The oven will be used to carry out optical measurements of the EC glazings at the selected test temperature. It shall be large enough for the largest EC glazing to be tested and shall be able to reach the EC glazing testing temperature. The oven shall also be designed to permit using the equipment in 5.2 and 5.3 for optical measurements while the EC glazing shall be maintained at the temperature chosen for testing in the test chamber (described in 5.1).