Designation: E2953 – 14

Standard Specification for Evaluating Accelerated Aging Performance of Electrochromic Devices in Sealed Insulating Glass Units[1]

This standard is issued under the fixed designation E2953; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification is applicable to all electrochromic (EC) glass whose visible light transmittance or near infrared light transmittance properties, or both, can be changed reversibly by the application or removal of an electrical voltage. This includes absorptive and reflective EC devices.

1.2 This specification does not apply to other types of dynamic glass which do not solely require an electrical stimulus to change light transmittance such as photochromic and thermochromic glazings and hybrid active/passive chromogenics.

1.3 This specification covers electrochromic devices in preassembled permanently sealed insulting glass units with one or more cavities in which at least one lite contains an EC device (which may be in the form of a laminated lite or a single pane with coatings applied). This specification is also applicable to EC devices in preassembled insulating glass units with capillary tubes intentionally left open. As such this specification also requires conformance to Specification E2190.

1.4 This specification is applicable only to sealed insulating glass units that are constructed with glass and fabricated for vision glass areas for use in buildings, such as sliding doors, windows, skylights, and exterior wall systems.

1.5 Qualification under this specification is intended to provide a basis for evaluating the aging performance of electrochromic devices in sealed insulating glass units.

1.6 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C162 Terminology of Glass and Glass Products
C717 Terminology of Building Seals and Sealants
E631 Terminology of Building Constructions
E2141 Test Method for Accelerated Aging of Electrochromic Devices in Sealed Insulating Glass Units
E2190 Specification for Insulating Glass Unit Performance and Evaluation

3. Terminology

3.1 *Definitions*—For definitions of terms found in this specification, refer to Terminologies C162, C717, and E631.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *dynamic range*—the visible light transmittance range of an EC device, measured as the difference between the visible light transmittance of the highest transmittance state and the lowest transmittance state.

3.2.2 *electrochromic device (ECD), n*—a combination of materials that include materials in which the transmittance, reflection, and absorption properties can be altered, and other layers, such as transparent conducting oxide (TCO) layers for altering the optical properties (for example, transmittance, reflectance, absorptance) of the device in response to an applied electric field.

3.2.3 *electrochromic (EC) glazing, n*—in a prepared opening of a building, the material installed which consists of an ECD with layer(s) of materials in which the optical properties can change in response to an applied electrical field, attendant materials, and one or more lites of glass.

3.2.4 *highest transmittance state, n*—also referred to as the *clear state* or *bleached state*, a descriptor for an EC glazing when it is in the transmittance state with the highest photopic specular light transmittance.

3.2.5 *lowest transmittance state, n*—also referred to as the *tinted state, dark state,* or *colored state*, a descriptor for an EC

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

glazing when it is in the transmittance state with the lowest photopic specular light transmittance.

3.2.6 *sealed insulating glass unit, n*—a preassembled unit, comprising lites of glass, which are sealed at the edges and separated by dehydrated cavity(s), intended for vision areas of buildings. The unit is normally used for windows, window walls, picture windows, sliding doors, patio doors, or other types of fenestration.

3.3 *Acronyms:*

3.3.1 *ECD*—electrochromic device

3.3.2 *IG*—insulating glass

3.3.3 *IGUs*—insulating glass units(s)

3.3.4 τ_H—specular (regular) transmittance in the *highest transmittance state*

3.3.5 τ_L—specular (regular) transmittance in the *lowest transmittance state*

4. Performance Requirements

4.1 For the specimens tested to Test Method E2141, 6.1, visible light transmittance in the highest transmittance state and the lowest transmittance state shall change by no more than ±5 %T absolute. That is:

$$\tau_H(\text{initial}) - \tau_H(\text{final}) \leq 0.05 \quad (1)$$

$$\tau_L(\text{initial}) - \tau_L(\text{final}) \leq 0.05$$

where:

τ_H *(initial)* = visible light transmittance in the highest transmittance state measured prior to testing according to Test Method E2141,

τ_L *(initial)* = visible light transmittance in the lowest transmittance state prior to testing according to Test Method E2141,

τ_H *(final)* = visible light transmittance in the highest transmittance state measured after testing according to Test Method E2141, and

τ_L *(final)* = visible light transmittance in the lowest transmittance state measured after testing according to Test Method E2141.

4.2 Insulating glass test specimens containing the electrochromic device shall meet the requirements of Specification E2190.

5. Test Specimens

5.1 Five identical specimens (each in an IGU) shall be prepared for testing to Test Method E2141. One specimen shall remain untested for comparison per Test Method E2141 and four shall be exposed to the test conditions according to Test Method E2141. The minimum test specimen size is 250 by 250 mm. Four specimens must be able to fit onto the test plane simultaneously.

5.2 Test specimens for determining conformance to Specification E2190 shall be prepared as described in Specification E2190 and shall be constructed with all EC coatings, electrical connections and seal penetrations (such as busbars, connectors, wires or electrical feedthroughs) in place in order to ensure the impact of the electrical system integration on the aging of the IGU is tested.

6. Test Methods

6.1 *Test Method E2141:*

6.1.1 Follow Test Method E2141.

6.1.2 The specimen test temperatures as measured at the center of the outer surface of the EC pane in the IGU shall be 85 ± 7°C.

6.1.3 Take one set of visible light transmittance measurements in the highest and lowest transmittance states in the center of the glass. Do not measure the transmission in the location where tape has been used to hold or shield the thermocouple has shielded the glass from the incident radiation.

6.1.4 The transmittance measurements of the highest and lowest transmittance states shall be made after waiting for 30 min from the start of the transition for the specimens to reach their extreme states or until the rate of change of transmittance is less than 0.4 %T per min, whichever occurs first.

6.2 *Specification E2190:*

6.2.1 Ensure specimens in 5.2 have passed the specification requirements found in Specification E2190. If gas filled EC IGUs are not to be certified, 4.3 of Specification E2190 does not apply.

7. Qualification

7.1 When at least three of the four test specimens have met the requirements as described in Section 4, this set of test specimens shall be deemed to be qualified according to this specification at the Exterior Glazed Product Classification or the Room-Side Glazed Product Classification, depending on the selected specimen orientation during the test. The Exterior Product Classification is for those products that meet this specification after being tested with the lite containing the EC device closest to the lamp source, and the Room-Side Product Classification is for those products that meet this specification after being tested with the lite containing the EC device furthest away from the lamp source.

7.2 If more than one specimen fails to meet the requirements for any reason including accidental damage, this set of specimens shall not be qualified according to this specification.

8. Report

8.1 Two separate reports shall be generated, one for conformance related to Test Method E2141 (4.1 and 4.2) and one related to conformance to Specification E2190 (4.3).

8.2 *Test Method E2141 Report:*

8.2.1 Report all information as required in the Report section of Test Method E2141.

8.2.2 Report the orientation of the EC containing lite in the insulating glass unit relative to the radiation source (that is, was it tested in an exterior lite or room side lite glazed EC configuration).

8.2.3 Report a full description of the make-up of the EC insulating glass unit tested, including a description of the EC

pane and the non-EC pane, the cavity dimension and any additional films or coatings, or both.

8.2.4 Report initial and final transmittance values for center of glass for the four samples as is shown in Table X1.1 in the appendix.

8.2.5 Record the elapsed time at which the %T measurements were made (initial and final).

8.2.6 Record the number of cycles and exposure hours under test conditions.

8.2.7 Report whether or not the set of specimens meets the qualifications of this specification related to coating aging performance per Test Method E2141 to either the Exterior Glazed Product Classification standard or the Room-Side Glazed Product Classification standard.

8.3 *Specification E2190 Report:*

8.3.1 Report all information as required by Specification E2190.

8.3.2 Report whether or not the set of test specimens meets the qualifications of this specification related to EC insulating glass unit performance per Specification E2190.

9. Keywords

9.1 chromogenic glazing; dynamic glazing; electrochromic; electrochromic aging performance; sealed insulating glass units

APPENDIX

(Nonmandatory Information)

X1. EXAMPLE OF REPORT FORM DETAILING TEST RESULTS FOLLOWING TEST METHOD E2141

TABLE X1.1 Example of Report Form Detailing Visible Light Transmittance Performance

Specimen	Transmittance State	Initial Visible Light Transmittance	Final Visible Light Transmittance	Difference Between Final and Initial Light Transmittance	Specification	Meet Specification?
Specimen 1	highest transmittance state				±0.05	Y/N
	lowest transmittance state				±0.05	Y/N
Specimen 2	highest transmittance state				±0.05	Y/N
	lowest transmittance state				±0.05	Y/N
Specimen 3	highest transmittance state				±0.05	Y/N
	lowest transmittance state				±0.05	Y/N
Specimen 4	highest transmittance state				±0.05	Y/N
	lowest transmittance state				±0.05	Y/N