Designation: E2355 – 10

Standard Test Method for Measuring the Visible Light Transmission Uniformity of an Absorptive Electrochromic Coating on a Glazing Surface[1]

This standard is issued under the fixed designation E2355; 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 The test described is a method for measuring the uniformity of an absorptive electrochromic coating (ECC) in a static colored or bleached state on a glazing surface, which is or will be one of two or more glazings in a preassembled permanently sealed insulating glass unit (IGU).

1.2 The test method is applicable only for layered (one or more active coatings between the TCOs) absorptive ECCs on vision glass (superstrate and substrate) areas planned for use in buildings, such as glass doors, windows, skylights, and exterior wall systems. The layers used for electrochromically changing the optical properties may be inorganic or organic materials between the superstrate and substrate and may include laminates.

1.3 The test method is not applicable to other types of coatings on vision glass with other chromogenic coatings that cannot be held in a static colored or bleached state.

1.4 The test method is not applicable to IGUs that will be constructed from superstrate or substrate materials other than glass.

1.5 The test method is not applicable for measuring the uniformity of ECC coatings during the coloring or bleaching processes.

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 There is no comparable International Standards Organization Standard.

1.8 *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 requirements prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C168 Terminology Relating to Thermal Insulation

C1048 Specification for Heat-Strengthened and Fully Tempered Flat Glass

E2141 Test Methods for Assessing the Durability of Absorptive Electrochromic Coatings on Sealed Insulating Glass Units

E2188 Test Method for Insulating Glass Unit Performance

E2189 Test Method for Testing Resistance to Fogging in Insulating Glass Units

E2190 Specification for Insulating Glass Unit Performance and Evaluation

E2240 Test Method for Assessing the Current-Voltage Cycling Stability at 90°C (194°F) of Absorptive Electrochromic Coatings on Sealed Insulating Glass Units

E2241 Test Method for Assessing the Current-Voltage Cycling Stability at Room Temperature of Absorptive Electrochromic Coatings on Sealed Insulating Glass Units

3. Terminology

3.1 *Definitions*—Refer to Terminology C168 for definitions of general terms.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *bleached state*—a descriptor for an EC coating when no ions reside in the electrochromic layer or after ions have been removed (or inserted, depending on the type of material) from the electrochromic layer(s) and if applicable, the maximum number of ions have been returned to the counterelectrode layer to restore the photopic optical specular transmittance in the bleached state (τ_b) from that of the photopic optical specular transmittance in the colored state (τ_c).

3.2.2 *colored state*—a descriptor for an EC coating after ions have been inserted (or removed, depending on the type of material) into the electrochromic layer and, if applicable,

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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.

removed from the counterelectrode layer to reduce the photopic optical specular transmittance (of wavelengths from 400 nm to 730 nm) from that in the bleached state (τ_b).

3.2.3 *durability*—the capability of maintaining the serviceability of a product, component, assembly, or construction over a specified time.

3.2.4 *electrochromic coating (ECC)*—the multilayered materials that include the electrochromic layers, other layers, and transparent conducting oxide layers required for altering the optical properties of the coating.

3.2.5 *electrochromic layer(s)*—the material(s) in an EC glazing that alter its optical properties in response to the insertion or removal of ions, for example, Li^+ or H^+.

3.2.6 *electrochromic (EC) glazing*—a device with an ECC consisting of several layers of electrochromic and attendant materials and one or more lites of glass, which are able to alter their optical properties in response to a change in an applied electric field. The changeable optical properties include transmittance, reflectance, and absorptance result in changes in the solar heat gain, visible transmittance, and U-factor of the glass.

3.2.7 *fenestration*—any opening in a building's envelope including windows, doors, and skylights.

3.2.8 *performance parameters*—the photopic transmittance ratio (PTR) between the bleached and colored states; coloring and bleaching times; and open-circuit memory.

3.2.9 *photopic transmission ratio (PRT)*—the ratio of the photopic transmission in the highest transmission, bleached state (τ_b) to the photopic transmission in the lowest transmission (colored) state, (τ_c). PTR= τ_b / τ_c.

3.2.10 *sealed insulating glass unit*—is defined in Specification E2190 but see also Appendix X1, Section X1.3.

3.2.11 *serviceability*—the capability of a building product, component, assembly, or construction to perform the function(s) for which it was designed and constructed.

3.2.12 *uniformity*—the variation in visible light transmission within an EC glazing.

3.3 For additional useful definitions for terminology used in this standard, see Appendix X1, Section X1.3.

4. Significance and Use

4.1 The ECCs used in the test method will ultimately be exposed (Test Method E2141) to solar radiation and deployed to control the amount of radiation by absorption and reflection and thus, limit the solar heat gain and amount of solar radiation that is transmitted into the building.

4.2 The test method referenced herein is a laboratory test conducted under specified conditions. This test method is intended for use in assessing the changes in uniformity of an ECC on vision glass and subjected to a series of tests for assessing the durability of the coating or the IGU unit, or both.

4.3 The useful life of IGUs with an absorptive ECC may depend on their ability to maintain an acceptable uniformity when used in an IGU for buildings applications. As described in Section 1.[3] (See Appendix X1, X1.4 and X1.5), this test method is intended to provide a means for measuring the uniformity of an absorptive electrochromic coating (ECC) on a glazing surface (including when sealed in an insulating glass unit).

4.4 *Effects of Test Procedures*—Data generated using this test method may be used to evaluate and compare the effects of subjecting ECCs in IGUs to the accelerated weathering procedures described in Test Methods E2141, E2240, or E2241. This test method requires the measurement of uniformity as a basis for evaluating changes in one of several performance parameters.

4.4.1 Changes in the uniformity of the test specimens may vary from none to significant. Some physical changes in the specimens may be visible when there are no apparent changes in the performance. Similarly, performance changes may occur with no visible changes in the specimens.

4.4.2 All conditions of measurement in this test method must be described in the report so that an assessment of their significance can be made.

4.5 *Sequencing*—If this test method is performed as part of a combined sequence with other measurements of the ECC perfomance (see 8.2) and visual inspection (see 8.3 in Test Methods E2141, E2240, or E2241) determined at the end of one of the test methods, the result may be used as the initial uniformity measurement for the next test; duplication of these uniformity measurements is not necessary unless so specified.

5. Background

5.1 Durability is a critical requirement for and EC glazing product for use on the building envelope. In selecting the materials, device design, and glazing for any application, the ability of the glazing to perform over time is an indication of that glazing's durability. The purpose of this standard test method is to measure the uniformity of an absorptive electrochromic coating (ECC) on a glazing surface.

5.2 EC IGUs perform a number of 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 human comfort (heat gain), security, ventilation, illumination, and glare control; providing for architectural expression; and (possibly) improving acoustical performance. Some of these functions may deteriorate in performance over time. Large changes in the uniformity of an ECC on a glazing surface may result in an unacceptable visual connection with the outside world, illumination, glare control, or in the architectural expression by the fenestration product.

6. Apparatus

6.1 *Laboratory Space,* that is large enough for the largest ECC-glass specimen to be measured and that will maintain the

[3] Czanderna, A. W., Benson, D. K., Jorgensen, G. J., Zhang, J-G., Tracy, C. E., and Deb, S. K., "Durability Issues and Service Lifetime Prediction of Electrochromic Windows for Buildings Applications," NREL/TP-510-22702, *National Renewable Energy Laboratory*, Golden, CO, May 1997; Solar Energy Materials and Solar Cells, 56, 1999, pp. 419-436.

ECC testing temperature at 22 ± 3°C (72 ± 5°F). The space must permit using the equipment needed for making the uniformity measurements.

6.2 *Positioning Mechanism,* that will hold and position the light source-detector pair(s) above and under the ECC sample. Because the sample sizes can vary, the light source-detector pair(s) shall be moveable and adjustable.

6.3 *Holding Mechanism,* that will hold a coated glass specimen in the central position between the light source and detector and that maintains the correct beam size diameter (within the allowed tolerance). The repeatability of positioning is to be ±3 mm. Clamp the source and detector pair to the glass during measurement to avoid stray light.

6.4 *Computer Controlled Photodiode Array Spectrophotometer,* for obtaining and storing data from the electro-optical characterization of the optical transmittance in the colored and bleached state. The resolution of the transmittance (T) measurement shall be 0.1 %T.

6.4.1 *Broadband Lamp,* that will provide a broadband spectrum from the light source and that must be compatible with illuminating the photodiode array spectrophotometer described in 6.4 and that will provide sufficient intensity from 400 to 720 nm. The illumination spot size of the source on the sample shall be 50 ± 3 mm in diameter. Choose a source of "cool" light to minimize localized heating that could adversely impact the uniformity of the ECC. The stability of the lamp for making the transmittance measurements shall be sufficient to provide the needed accuracy and precision.

NOTE 1—A 5-cm diameter spot size provides good reproducibility of the measurement of any broad non-uniformities in the ECC and allows precision measurements to be made without placing tight tolerances on the position of the spot. The measurement may also be made with a smaller spot size, for example, 2-cm that is sequentially positioned until the area of a 5-cm diameter circle has been sampled.

6.4.2 *Transmittance Measurements,* to a precision of ±0.5 % T and with an accuracy of ±2 % of the measured transmittance or ±0.5 % in transmittance, whichever is the greater.

NOTE 2—The accuracy is ±0.5 % in the measured transmittance up to T = 25 % and then 2 % of the transmittance value for all T > 25 %. Thus, the two criteria prevent specifying an unrealistic measurement accuracy at small values of T, such as in the colored state.

6.5 *Transmission Standards,* to calibrate the equipment appropriately. To calibrate the transmittance (T) measurements, select transmission standards that span the entire dynamic range to be measured. For example, if an ECC sample with a dynamic transmittance range of 55 to 4 % is to be measured, calibration standards in the range of T = 3 to 5 % and in the range of T = 50 to 60 % are required.

6.6 *Temperature Measurement Equipment*—Use an instrument or instruments to measure the temperature of the specimen during the uniformity measurements. The results shall be accurate to ±0.1°C (±0.2°F) with a total error of less than ±0.3°C (±0.5°F) of the reading.

6.7 *Temperature Sensors,* suitable for the room temperature range, such as thermocouples, are attached to the portions of the test specimens that will provide the best measurement of the ECC temperature. If more than one specimen of identical size, design, and construction is tested simultaneously, it is not necessary to monitor the temperature of all identical specimens.

6.8 *Voltage Cycling Unit,* for imposing voltage cycles to alternately color and bleach the ECCs from a fully bleached state to the fully colored state and back to the fully bleached state.

6.9 *Digital Camera,* for taking photographs of the specimens.

7. Test Specimen

7.1 Test specimen size, design, and construction shall be established and specified by the user of this standard, except the specimens shall be at least 250 by 250-mm.

NOTE 3—Consideration should be given to the ultimate requirement for testing specimens that are 355 ± 6 mm by 505 ± 6 mm such as those used in Test Methods E2188 and E2189, and for using heat-strengthened or tempered glass (see Specification C1048). Consult Section 5 in Test Method E2188 for a description of test specimens and their preparation.

NOTE 4—The test method may also be used for smaller, prototype EC IGUs or EC laminated structures for measuring the uniformity of an absorptive electrochromic coating (ECC) on a glazing surface.

7.2 Six test specimens that are represented to be "identical" shall be supplied for measuring the uniformity of an absorptive electrochromic coating (ECC) on a glazing surface, which will ultimately be one of two or more of the lites in a preassembled permanently sealed insulating glass unit (IGU).[3] (See Appendix X1, Section X1.5.)

7.3 The manufacturer shall provide control parameters and other information that are needed by the testing laboratory for carrying out this test.

7.4 The testing laboratory shall retain two of the supplied units as control specimens.

8. Procedure

8.1 *Overview*—Prior to making the uniformity measurements, the ECC sample shall be at a steady state, that is, the rate of change of transmittance at any given point on the area of the coating must be a minimum. The manufacturers shall provide the control hardware (ECC control system) and instructions for how to achieve this constant transmission state. To assure that steady state has been reached, the uniformity measurements should begin, as a guide, 30 min after a change to the colored or bleached state has been initiated. However, the time chosen for the onset of making uniformity measurements shall take into account variations in the dynamic response between samples from different manufacturers, of different technologies, and of different size. The temperature range for the testing environment and the sample being measured shall be 22 ± 3°C. Visible light transmittance shall be measured at a number of specified and fixed points on a sample as given in 8.6.

8.2 *Electro-optic Characterization*—Perform electro-optic characterization as described in Test Method E2141, sections 8.2 and 8.2.1 before and after making the uniformity measurements. Calculate the photopic transmittance ratio from the optical transmittance data in the bleached and colored states as

described in Test Method E2141, section 9.2. If the photopic transmittance ratio (PTR) is less than four for the ECC on the glass substrate, do not proceed but secure new specimens that have a PTR that exceeds 5.

8.3 *Instrumentation*—Attach one or more temperature sensors to the exterior of the test specimens following the requirements of Section 6.8. Locate each sensor so that it will not interfere with any transmittance measurement.

8.4 Mount the specimens for the tests in 8.6 as described in 6.2 and 6.3.

8.4.1 *Mounting*—Mount the test specimens so that the ECC coating on the glass is nearest the detector.

8.5 *Uniformity Measurements*—Measure the uniformity in the fully bleached and fully colored states at the points specified in 8.7. First, darken the device to the fully colored state in the manner specified by the manufacturer and measure the uniformity in the colored state after it has reached steady state (see 8.1). Then bleach the device to the fully bleached state according to manufacturer's instructions and measure the uniformity in the bleached state.

8.6 *Measurement Points*—Measure the transmittance at the five points shown in Fig. 1. One point is at the center of the sample (where the diagonals cross) and the other four are at each corner centered 7.5 cm away from each edge. Make three transmittance measurements at each of the five points. Achieve this by making one measurement at each of the points in the sequence point A-point B-point C-point D-point E and repeat this sequence twice. Take the mean of the three measurements at each point ($\Sigma t_i/3$) to provide the transmittance T_i for each measurement point. If one measurement is either 0.5 %T absolute or 10 % relative, whichever is the larger, greater or less than the mean at that point, discard the measurement and make another measurement of the outlier(s). Do not make more than two repeat measurements for outliers.

8.7 *Calculation of the Mean Transmittance*—Calculate the overall mean, *X*, and range, *R*, of the visible light transmittance measurements made at each of the five points. Follow the sequence of steps for this calculation as given in Table 1. The Range is defined as $T_{max} - T_{min}$, where T_{max} is the maximum transmittance in the data set and T_{min} is the minimum transmittance in the data set. The overall mean ($\%T_{mean}$) is defined as $\Sigma(T_i)/n$, where *n* is the total number of measurements (5 here) and T_i is the mean transmittance at each individual point.

9. Observations

9.1 Observe and document the following:

9.1.1 Specimen breakage,

9.1.2 Specimen failure that is indicated by a PTR of less than 5,

9.1.3 Specimen degradation that is visually evident in the colored state,

9.1.4 Specimen degradation that is evident from photographs in the bleached state, and

9.1.5 Specimen degradation that is evident from photographs in the colored state.

10. Report

10.1 Give a complete description of the test specimen(s) including the observations of the as-received specimens.

10.1.1 Give the dimensions of the test specimen (width by height) and overall thickness.

10.1.2 List the type and thickness of the glazing.

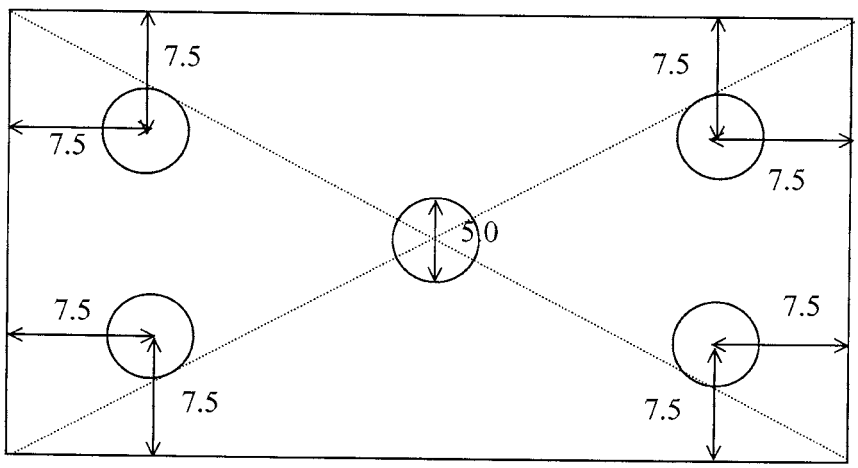
10.1.3 Provide a description of the absorptive ECC including the glazing surface onto which it was deposited and glazing format (that is, IGU or laminate).

10.1.4 List the manufacturer (including location) and manufactured date (month, if known, and year).

10.2 Note any observed specimen breakage.

10.3 Include other additional information such as technical drawings in the test report.

10.4 Prepare a report for each set of EC glazings after measuring the uniformity of the absorptive electrochromic coating (ECC) in the colored and bleached state. Provide the PTR before and after the uniformity measurements. As with the



NOTE 1—All dimensions are in centimetres.

FIG. 1 Location of the Five Measurement Points for Establishing the Uniformity of an ECC on a Glazing Surface

TABLE 1 Step-by-step Procedure for Recording for the Colored State the %T (Columns A through E), Calculating the Mean and Range of the Uniformity of an ECC on a Glazing Surface, and Rejecting Outliers

Line	Header	Sect.	Spot Postion on EC Device	A	B	C	D	E
1	data	8b	measurement #1					
2	data	8b	measurement #2					
3	data	8b	measurement #3					
4	sum	8c	sum of each column					
5	mean $\%T_i$ of each spot	8c	sum of each column divided by 3					
6	outlier rejection	8c	subtract the mean %T (line 5) from the maximum of the 3 measurements per spot.					
7	outlier rejection	8c	divide the result in line 6 by the mean $\%T_i$. (line 5)					
8	outlier rejection	8c	if the above result (line 7) is 0.1 or greater, re-measure that spot and redo all calculations					
9	outlier rejection	8c	if the result of line 6 is greater than 0.5 %, remeasure that spot and redo all calculations					
10	outlier rejection	8c	subtract the mean %T from the minimum of the 3 measurements per spot.					
11	outlier rejection	8c	divide line 10 by the mean $\%T_i$ (line 5)					
12	outlier rejection	8c	if the result in line 11 is –0.1 or more, re-measure that spot and redo all calculations					
13	outlier rejection	8c	if the result on line 10 is more than -0.5 %, re-measure that spot and redo all calculations					
14	the overall mean	9b	for the overall mean *X* of the mean transmittances at each point, $\%T_i$, add the numbers under the five columns A-E in line 5 together and divide by 5					
15		9a	enter the maximum transmittance, $\%T_{max}$, of the five numbers in line 5.					
16		9a	enter the minimum transmittance, $\%T_{min}$, of the five numbers in line 5.					
17	the range	9a	to calculate the range, subtract line 16 from line 15 and enter					

TABLE 2 Step-by-step Procedure for Recording for the Bleached State the %T (Columns A through E), Calculating the Mean and Range of the Uniformity of an ECC on a Glazing Surface, and Rejecting Outliers

Line	Header	Sect.	Spot Postion on EC Device	A	B	C	D	E
1	data	8b	measurement #1					
2	data	8b	measurement #2					
3	data	8b	measurement #3					
4	sum	8c	sum of each column					
5	mean $\%T_i$ of each spot	8c	sum of each column divided by 3					
6	outlier rejection	8c	subtract the mean %T (line 5) from the maximum of the 3 measurements per spot.					
7	outlier rejection	8c	divide the result in line 6 by the mean $\%T_i$. (line 5)					
8	outlier rejection	8c	if the result on line 7 is 0.025 or greater, re-measure that spot and redo all calculations					
9	outlier rejection	8c	if the result of line 6 is greater than 1.5 %, remeasure that spot and redo all calculations					
10	outlier rejection	8c	subtract the mean %T from the minimum of the 3 measurements per spot.					
11	outlier rejection	8c	divide line 10 by the mean $\%T_i$ (line 5)					
12	outlier rejection	8c	if the result in line 11 is –0.025 or more, re-measure that spot and redo all calculations					
13	outlier rejection	8c	if the result on line 10 is more than -1.5 %, re-measure that spot and redo all calculations					
14	the overall mean	9b	for the overall mean *X* of the mean transmittances at each point, $\%T_i$, add the numbers under the five columns A-E in line 5 together and divide by 5					
15		9a	enter the maximum transmittance, $\%T_{max}$, of the five numbers in line 5.					
16		9a	enter the minimum transmittance, $\%T_{min}$, of the five numbers in line 5.					
17	the range	9a	to calculate the range, subtract line 16 from line 15 and enter					

quantitative data, summarize and include the visual observations for the EC glazings in the custom report prepared for each supplier. When possible, summarize the observations in general for all EC glazings and then make appropriate additional comments for each sample. After the final electro-optic characterization, place each exposed EC glazing side by side with the control sample (not subjected to any uniformity measurements) and take a photograph to document the effects of any degradation that might have resulted from the uniformity measurements by using the 22°C electro-optical coloring/bleaching protocols. Carefully pack and store the tested EC glazing samples subjected to the testing.

11. Precision and Bias

11.1 *Precision*—The precision of the procedures in this test method is being determined.

11.2 *Bias*—Because there are no accepted reference materials suitable for determining the bias for the procedures in this test method, bias has not been determined.

12. Keywords

12.1 chromogenic glazing; durability; electrochromic windows; fenestration; insulating glass units; sealed insulating glass units

APPENDIX

(Nonmandatory Information)

X1. ADDITIONAL INFORMATION

X1.1 Acronyms Used in This and Related Test Methods

X1.1.1 ALT = accelerated life testing

X1.1.2 I-V = current-voltage

X1.1.3 ECC(s) = electrochromic coating(s)

X1.1.4 IG = insulating glass

X1.1.5 IGU(s) = insulating glass unit(s)

X1.1.6 IR = infrared (radiation)

X1.1.7 PTR = photopic transmittance ratio or $\text{transmittance}_{\text{bleached}}$ / $\text{transmittance}_{\text{colored}}$

X1.1.8 TCO(s) = transparent conducting oxide(s)

X1.1.9 UV = ultraviolet (radiation)

X1.1.10 V = voltage

X1.2 Additional Useful Standards Related to This Standard

X1.2.1 ASTM Standards (Refer to Terminology G113 for a Description of General Terms):[2]

C1036 Specification for Flat Glass

C1172 Specification for Laminated Architectural Flat Glass

C1199 Test Method for Measuring the Steady State Thermal Transmittance of Fenestration Systems Using Hot Box Methods

E122 Practice for Calculating Sample Size to Estimate, with a Specified Tolerable Area, the Average for Characteristic of a Lot or Process

E546 Test Method for Frost Point of Sealed Insulating Glass Units

E773 Test Method for Accelerated Weathering of Sealed Insulating Glass Units

E774 Specification for the Classification of the Durability of Sealed Insulating Glass Units

E903 Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres

E1423 Practice for Determining the Steady State Thermal Transmittance of Fenestration Systems

E1887 Test Method for Fog Determination

E2189 Test Method for Testing Resistance to Fogging in Insulating Glass Units

G113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials

X1.3 Additional Useful Definitions for Terminology Used or Referenced in This Standard

X1.3.1 *accelerated life testing*—a protocol that results in accelerated aging of materials or devices.

X1.3.2 *chromogenic glazing*—a glazing consisting of one or more layers of chromogenic materials, which are able to alter their optical properties in response to a change in ambient conditions such as illumination intensity, termperature, applied electric field, and so forth. The changeable optical properties include transmittance, reflectance, absorptance, and emittance.

X1.3.3 *counter electrode layer*—the ion storage material in an EC glazing that serves as a reservoir for ions that can be inserted into or received from the electrochromic layer.

X1.3.4 *degradation factors*—refer to conditions, imposed or natural, that influence or cause a degradation mechanism, effect, or mode.

X1.3.5 *electro-optic characterization*—refers to the process of recording optical changes (transmittance, reflectance, absorptance, and so forth) in an EC glazing as a function of electrical protocols (voltage, current).

X1.3.6 *electro-optic cycling*—refers to the electrochemical cycling process of applying repetitive positive and negative voltages to an EC glazing for the purpose of reversibly changing the optical properties of the EC device from the bleached to the colored state.

X1.3.7 *ion storage layer or counter electrode layer*—the material in an ECC that serves as a reservoir for ions that can be inserted into the electrochromic layer.

X1.3.8 *optical photopic transmittance ratio*—refers to the ratio of the bleached state transmittance (τ_b) to the colored state transmittance (τ_c) where τ_b and τ_c are both weighted by a spectral photopic response curve.

X1.3.9 *optical transmittance*—the ratio of the radiant energy transmitted by a body to the total radiant energy incident upon the body.

X1.3.10 *photodiode array spectrophotometer*—an optical detector system that uses an array of photodiodes coupled to CCDs to facilitate UV-VIS-NIR spectroscopic measurements.

X1.3.11 *sealed insulating glass unit*—a preassembled unit, comprising lites of glass, which are sealed at the edges and separated by dehydrated spaces(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.

X1.3.12 *spectral photopic response*—refers to the relative response of the human eye in its light adapted state (daylight) to radiation of a given wavelength in the spectral region of ~410 to 720 nm.

X1.3.13 *specular transmittance*—refers to the optical transmittance that does not include light with a diffuse component.

X1.3.14 *trapezoidal voltage profile*—the geometric shape generated by plotting the voltage versus time applied to an EC glazing with a slope in V/s up to a constant voltage and then a negative slope in V/s back to zero voltage.

X1.4 The suitability of the test method will be further evaluated as the analyses of test results are completed.

X1.5 The total number of specimens supplied shall be two more than the number listed in section 7.2 and shall serve as control specimens or to allow for breakage of two specimens.