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Standard Test Method for Accelerated Aging of Environmentally Controlled Dynamic Glazing[1]

This standard is issued under the fixed designation E3119; 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 test method covers the accelerated aging and monitoring of the time-dependent performance of environmentally controlled dynamic glazings such as thermochromic (TC) thermotropic, photochromic glazings. and combinations thereof.

1.2 The test method is applicable only for environmentally controlled dynamic glazings. These glazings may be either monolithic glass, monolithic laminated glass, or sealed insulating glass units fabricated for use in buildings, such as exterior doors, windows, skylights, and wall systems.

1.3 During use, the environmentally controlled dynamic glazings tested according to this method are exposed to environmental conditions, including solar radiation and are employed to control the amount of transmitted radiation by absorption and reflection and thus, limit the amount of solar radiation that is transmitted into a building.

1.4 The test method is not applicable to electronically controlled chromogenic devices, such as electrochromic devices.

1.5 The test method is not applicable to environmentally controlled dynamic glazings that are constructed from superstrate or substrate materials other than glass.

1.6 The test method referenced herein is a laboratory test conducted under specified conditions.

1.7 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.9 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E230/E230M Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples

E631 Terminology of Building Constructions

E2141 Test Method for Accelerated Aging of Electrochromic Devices in Sealed Insulating Glass Units

E3120 Specification for Evaluating Accelerated Aging Performance of Environmentally Controlled Dynamic Glazings

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

G151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources

G155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials

G173 Tables for Reference Solar Spectral Irradiances: Direct Normal and Hemispherical on 37° Tilted Surface

2.2 *ISO Standard:*[3]

ISO 9050 Glass in building–Determination of light transmittance, solar direct transmittance, total solar energy transmittance, ultraviolet transmittance and related factors

3. Terminology

3.1 *Definitions*—Refer to Terminology in E631 and G113 for descriptions of general terms.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *accelerated aging test, n*—a test in which the rate of degradation of building components or materials is intentionally increased from that expected in actual service.

[1] This test method is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.22 on Durability Performance of Building Constructions.

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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.

[3] Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.

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3.2.2 *environmentally controlled dynamic glazing (ECDG), n*—in a prepared opening of a building, the glazing material installed in which the optical properties can change in response to environmental stimuli such as sunlight and/or temperature.

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

3.2.4 *lateral uniformity, n*—the degree of variation in the amount of irradiance in the *x* and *y* directions in the test plane used for exposing an ECDG glazing.

3.2.5 *layer temperature, n*—the temperature, as measured by a thermocouple, of the lite having environmentally responsive properties.

3.2.6 *photochromic glazing, n*—an environmentally controlled dynamic glazing which changes its optical properties in response to exposure to solar radiation.

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

3.2.8 *solar irradiance, n*—as related to natural weathering of materials, the irradiance of the sun incident on the earth's surface, having wavelengths between 295 nm and 4050 nm.

3.2.9 *specular (regular) transmittance, n*—the optical transmittance that does not include light with a diffuse component.

3.2.10 *thermochromic glazing, n*—an environmentally controlled dynamic glazing which changes its optical properties in response to exposure to a broad range of temperatures (≥10 °C).

3.2.11 *thermotropic glazing, n*—an environmentally controlled dynamic glazing which changes its optical properties at a discrete temperature or over a small range of temperatures (that is, <10 °C).

3.2.12 *transition temperature, n*—specifically in thermotropic ECDG, it is temperature at which the optical properties of a given glazing switches between highest transmittance state and lowest transmittance state.

3.2.12.1 *Discussion*—In thermochromic glazing, the optical properties change continuously over a broad temperature range (that is, ≥10 °C) and so do not have a transition temperature.

3.3 *Acronyms:*

3.3.1 *AWU*—accelerated weathering unit.

3.3.2 *ECDG*—environmentally controlled dynamic glazing.

3.3.3 *IGU(s)*—insulating glass unit(s).

3.3.4 *NIR*—near-infrared (radiation).

3.3.5 T_H—highest specified temperature for recording specular transmittance.

3.3.6 T_L—lowest specified temperature for recording specular transmittance.

3.3.7 T_M—midrange specified temperature for recording specular transmittance.

3.3.8 *UV*—ultraviolet (radiation).

4. Significance and Use

4.1 ECDG perform a number of important functions in a building envelope including: reducing the solar energy heat gain; providing a variable visual connection with the outside world; enhancing human comfort (heat gain), security, illumination, and glare control; providing for architectural expression, and (possibly) improving acoustical performance. It is therefore important to understand the relative serviceability of these glazings.

4.2 This test method is intended to provide a means for assessing the relative serviceability of ECDGs, as described in Section 1.

4.3 The test method is intended to simulate in-service use and accelerate aging of the environmentally controlled dynamic glazings.

4.4 Results from these tests cannot be used to predict the performance over time of in-service units unless actual corresponding in-service tests have been conducted and appropriate analyses have been conducted to show how performance can be predicted from the accelerated aging tests.

4.5 The procedure in this test method includes environmental test parameters that are typically used in weatherability tests by standards organizations and are realistic for the intended use of large-area ECDG units.

5. Apparatus

5.1 *Accelerated Weathering Unit (AWU),* consisting of a temperature controlled chamber with properly filtered xenon-arc lamp(s) to simulate the spectral power distribution of solar radiation over the UV/Visible and NIR wavelength region (Tables for Reference G173) operated in accordance with Practice G155.

5.1.1 Fig. 1 shows a top-view schematic diagram of the essential features of the environmental test chamber including the layout of the ECDG on a test plane of sufficient size to test at least four specimens simultaneously, the location of a sufficient number of xenon-arc lamps above the test plane to deliver the specified radiation intensity, and the necessary connecting thermocouple cables from the ECDGs to the computer-controlled data acquisition system.

5.1.2 Some means of adjusting the light intensity and uniformity on the test plane shall be provided in order to obtain the desired light intensity and lateral uniformity within the guidelines of this document. This can be provided through adjustment of the position of the test plane relative to the lamp(s) or through adjustment of the output of the lamps themselves. Temperature control within the test chamber shall be provided. Conditions inside the closed space shall be controlled for air temperatures from 20 to 95 °C. Humidity within the test chamber shall be monitored and shall not exceed 60 %.

5.1.3 Simulated solar radiation shall be provided by a spectrally filtered xenon arc lamp(s) housed within a reflector system. The lamps shall be suitably filtered to provide a match of the Hemispherical Solar Spectral Irradiance on 37° Tilted Sun-Facing Surface (Tables for Reference G173) from 300 to 900 nm (see Note 1). The lamps may employ a NIR absorbing

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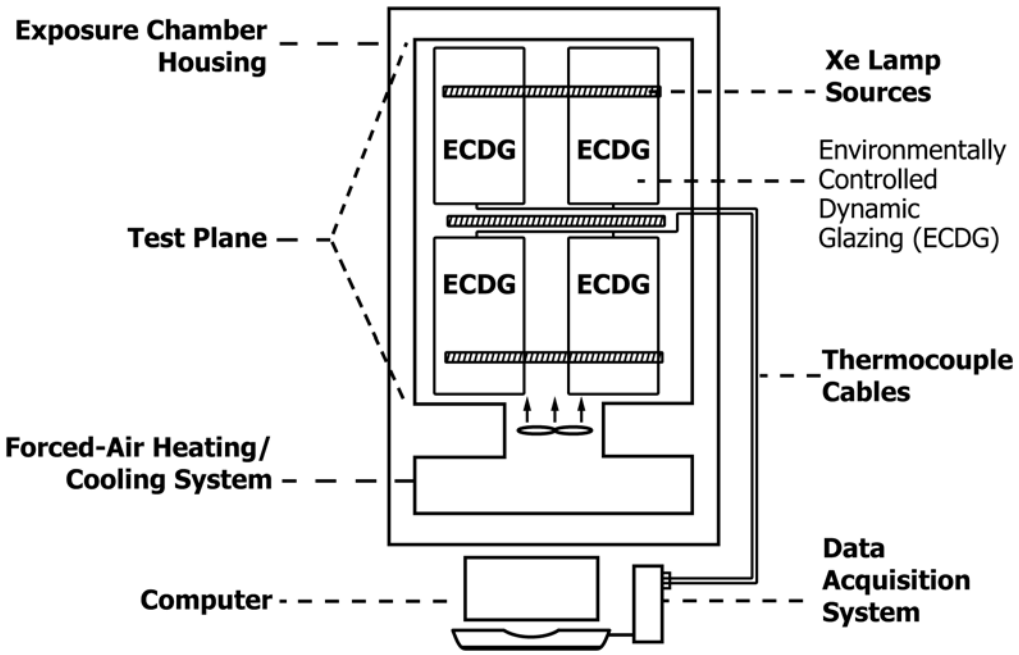

FIG. 1 Top-View Schematic Diagram of (Essential) Components of an Environmental Test Chamber and Data Acquisition System for Accelerated Aging of Environmentally Controlled Dynamic Glazings

filter to reduce the heat load in the chamber and allow appropriate temperature control.

NOTE 1—At longer wavelengths, the xenon arc emission is at variance with the Tables for Reference G173 hemispherical solar spectral irradiance 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 photolytically induced degradation.

5.1.4 The ECDG specimens are to be located on the test plane a given distance from the xenon arc lamps.

5.1.5 The AWU shall have a means for allowing thermocouple connections to pass from inside to the outside of the unit to allow temperature monitoring of the specimens.

5.2 *Spectrometer,* for acquiring the specular transmittance of test specimens.

5.2.1 *Spectrometer Light Source,* a tungsten lamp, or other suitable lamp source that provides illumination from 380 to 780 nm.

5.2.2 *Fiber Optic Cables,* which shall be routed from the lamp source into the ECDG specimen holder and from the ECDG specimen holder to the spectrometer. One optical fiber guides the incident light from the lamp source to one side of the specimen; another optical fiber guides the transmitted light to the spectrometer attached to a computer. The fibers shall be optically coupled by properly aligned collimating lens assemblies attached to both the illuminating and the collection fibers.

5.3 *Temperature Controlled Chamber* (see Fig. 2), capable of achieving the selected test temperatures for the test specimens. The temperature controlled chamber will be used to carry out optical measurements of the ECDGs at the selected test temperatures. It shall be large enough for the largest ECDG to be tested. The temperature controlled chamber must also be designed to permit using the equipment in 5.2 for optical measurements while the ECDG is maintained at the temperature chosen for evaluation of the specimens as defined in 7.3.1.

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

5.5 *Thermocouples,* with conformance to Specification E230/E230M verified, to measure specimen and chamber temperatures in the AWU and the temperature controlled chamber.

6. Reagents and Materials

6.1 Test Specimen size, design, and construction shall be established and specified by the manufacturer, except that the specimen shall be at least 150 ± 6 × 6 mm.

6.2 Refer to Specification E3120 for details on specimen quantity and size.

7. Procedure[4]

7.1 *Overview*—The ECDGs are exposed to simulated solar irradiance in a temperature controlled chamber at specimen temperatures ranging from 70 to 105 °C. Accept the prevailing relative humidity in the chamber but ensure that it does not exceed 60 %. The ECDG specimens are optically characterized (that is, the specular transmittance is recorded at several ECDG layer temperatures) in a temperature controlled chamber at the selected testing temperatures prior to exposure in the AWU in order to establish the performance characteristics of each sample. After exposure in the AWU, the specimens are optically characterized as they were initially to provide after-aging ECDG transmittance data.

[4] This procedure is based, in part, on ASTM Test Method for Accelerated Aging of Electrochromic Devices in Sealed Insulating Glass Units (E2141).