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Standard Practice for Evaluating the Service Life of Chromogenic Glazings[1]

This standard is issued under the fixed designation E2094; 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 practice is intended to provide guidance to architects, specifiers, manufacturers, and other parties who have an interest in evaluating the service life of chromogenic glazings.

1.2 This practice is intended to cover the main factors about service life that must be considered when evaluating glazings for performance until the failure time is reached. However, users of this practice must be aware that other factors must be considered, such as the effect of the interaction of materials, the use of the glazings, and to the environment in which a chromogenic glazing is exposed over its service life. Users of this practice are specifically cautioned to be aware that failure of the plastic polyurethane thermal barrier in an aluminum window containing a chromogenic blazing can cause a spreading or outward rotation of the glazing leges, called "hinging" or "clamming," which reduces the edge pressure on an insulated glazing (IG) unit, causing edge seal failure of the IG unit and allowing water to enter the IG unit and the glazing pocket.

1.3 The test methods referenced herein are laboratory tests conducted under specified conditions. These test methods are intended to simulate and, in some cases, to also accelerate actual in-service use of the chromogenic glazings. Results from these test methods cannot be used to predict the performance with time of units in the field unless actual corresponding field tests have been conducted and appropriate analyses have been conducted to show performance can be predicted from accelerated aging test methods.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C168 Terminology Relating to Thermal Insulation

E632 Practice for Developing Accelerated Tests to Aid Prediction of the Service Life of Building Components and Materials

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

3. Terminology

3.1 *Definitions*—Refer to the terminology given in Terminologies C168 and G113 and Practice E632 for definitions of general terms.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *accelerated aging test*—an aging test in which the rate of degradation of building components or materials is intentionally accelerated over that expected in actual service.

3.2.2 *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, temperature, applied electric field, and so forth. The changeable optical properties include transmittance, reflectance, absorptance, and emittance.

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

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

3.2.5 *service life (of a building component or material)*—the period of time after installation during which all properties exceed minimum acceptable values when routinely maintained.

4. Significance and Use

4.1 This practice is important because producers of chromogenic glazings cannot wait for real-time in-service use to assess the product lifetime. Thus, a procedure is needed to estimate failure times based on accelerated weathering and related factors and tests. This practice does not provide guidance for how to follow the steps outlined as follows, but it provides as much information as is practical in an ASTM practice.

5. Background

5.1 Observations and measurements have shown that some of the performance characteristics of chromogenic glazings have a tendency to deteriorate over time. In selecting materials and glazings for any application, the ability of that glazing to perform over time is an indication of that glazing's durability.

[1] This practice 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.

The ability of the product to perform over time, at or better than specified requirements, is an indication of the service life of the glazings. While these two indicators are related, the purpose of this practice is to address the service life of chromogenic glazings.

5.2 Chromogenic glazings perform a number of important functions in a building envelope including: providing for architectural expression, human comfort (heat gain/heat loss), security, ventilation, illumination and glare control, passive solar energy gain, minimization of the solar energy heat gain, (possibly) acoustical performance, and a visual connection with the outside world. These are some of the functions that may deteriorate in performance over time.

5.3 It is possible, but difficult to predict the time-dependent performance of a chromogenic glazing product from accelerated aging tests because of the reasons listed as follows. Users of this practice should be aware of these limitations when reviewing published performance results and their connection to durability or service life.

5.3.1 The degradation mechanisms (internal factors) of chromogenic materials or glazings, or both, are complex. In some cases, however, these mechanisms may be determined and quantified.

5.3.2 The external factors that affect chromogenic glazing performance are numerous and may be difficult to quantify. However, in some cases, the use, the environmental factors, and other information that influence performance may be known.

5.3.3 The fenestration units with a chromogenic glazing tested may be different from those planned for use in-service. Some companies have a database of in-service performance that can be compared to laboratory results.

6. Test Specimen

6.1 The test specimen shall be chosen to represent the various products available. They must be dynamically cycled.

7. Procedure

7.1 A general methodology for predicting the service life of chromogenic glazings as a fenestration component requires several steps. For a more complete description of the procedure, see Practice E632. If a service-life specification is stated, it is recommended that all evaluations be determined in accordance with these guidelines.

7.1.1 There exists a body of accepted fenestration components test methods and specifications (see Appendix X1). To meet the requirements of this practice, a product shall meet the applicable specifications, unless otherwise specified.

NOTE 1—All glazing specifications may not be applicable to all window types.

7.1.2 There exists a body of accepted fenestration assembly test methods (see Appendix X2). To meet the requirements of this practice, a chromogenic glazing, which is a component of the entire assembly, must maintain its functionality and the requirements specified therein, unless otherwise specified.

7.1.3 Use specimens of the final product for which a service life is desired.

7.1.4 Define and quantify the environmental factors to which the material(s), product, or component(s), or combinations thereof, are likely to be exposed in service.

7.1.5 Define the performance or failure criteria, or both, that will be used to establish the end of a components' service life.

7.1.6 Identify sensitive (and relevant) measurement(s) that can be correlated with performance.

7.1.7 Characterize the chromogenic glazing, for example, its physical composition, chemical properties, and microstructure of the material(s) in terms relevant to its degradation and its ability to maintain performance at a level exceeding or equal to the minimum expectations or to the failure criteria.

7.1.8 Subject multiple, replicate specimens of the complete chromogenic glazing to accelerated aging tests and to anticipated in-service exposure conditions and make periodic measurements of appropriate performance parameters. Perform actual field tests.

NOTE 2—Several sites should be selected with diverse environmental factors that span the range of in-service use.

7.1.9 Determine the mechanisms and kinetics of the degradation of the material(s) or components, or both, in sufficient detail to allow prediction of rates of degradation under anticipated in-service exposure conditions.

7.1.10 Develop and validate a model ideally, or models, if necessary for correlating the accelerated aging and in-service testing data for each type of exposure site.

7.1.11 Predict the service life using the model (or models), knowledge of the failure criteria and environmental factors, the physical and chemical properties of the material(s), or the entire chromogenic glazing, or combination thereof, and the correlations in 7.1.10.

7.1.12 Report the predictions for the anticipated in-service range of environmental factors, state how the predictions were made, and give explicit comments about the assumptions on which the predictions are based and the uncertainty associated with the prediction.

8. Limitations

8.1 This practice is divided into two parts: the first is a list of requirements for fenestration assemblies with chromogenic glazings that is based upon a number of existing test methods and standards; in the second part, appendixes are sets of test methods that describe procedures to measure or evaluate entire fenestration assemblies.

8.2 Any test specimen that fails during the testing because of a seal failure shall not be considered a properly qualified fenestration assembly.

9. Report

9.1 Report the following information:

9.1.1 A complete description of the test specimen(s).

9.1.2 The test methods performed on the test specimen(s) and the results of those test methods both before and after accelerated test methods were conducted.

9.1.3 The type of accelerated test methods conducted.

9.1.4 The number of dynamic cycles completed before failure occurs.