Designation: C1650 – 14

Standard Practice for Instrumental Reflectance Measurement of Color for Flat Glass, Coated, and Uncoated[1]

This standard is issued under the fixed designation C1650; 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 provides guidelines for the instrumental reflectance measurement of the color of flat, coated and uncoated glass. See Terminology E284.

1.2 The practice specifically excludes fluorescent and iridescent samples.

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

1.4 *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]

D2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates

E284 Terminology of Appearance

E179 Guide for Selection of Geometric Conditions for Measurement of Reflection and Transmission Properties of Materials

E308 Practice for Computing the Colors of Objects by Using the CIE System

E1164 Practice for Obtaining Spectrometric Data for Object-Color Evaluation

E1331 Test Method for Reflectance Factor and Color by Spectrophotometry Using Hemispherical Geometry

2.2 *CIE Standard:*[3]

CIE 15:2004 Colorimetry, Third Edition

3. Summary of Practice

3.1 The reflected color of glass products, (see Guide E179) is measured in reflectance specular included mode on a CIE-conforming diffuse geometry instrument. (See Test Method E1331 and CIE 15:2004.) The glass color is expressed in CIE tristimulus values based on spectral transmittance measurements over the full CIE spectral range of 350 – 780 nm with a maximum 10-nm band pass. (See CIE 15:2004 and Practice E308.) For color measurement, use of a truncated spectral range of 400 – 700 nm is acceptable. (See CIE 15:2004.) Further information on the UV absorbing characteristics of the glass or glass coating, or both, may be determined by examining the spectral data in the 350 – 400 nm range. If the instrument allows spectral measurement above 700 nm, useful information on the IR reflectance characteristics of the glass coating may also be determined. If coatings are present, they can be opaque or partially reflective.

4. Significance and Use

4.1 Color measurement quantifies the coating color for glass and is often related to coating thickness and composition as well as tinting used in the substrate glass. The user of this document defines an acceptable range of color appropriate for the end use. Typical quality concerns for the reflected color measurement of coated glass products are an indication of consistency in the coating process and verification of lot-to-lot color consistency for end-user acceptance.

4.2 If the reflected color of a glass product is consistent from lot-to-lot and within agreed supplier-buyer acceptance criteria, that product color is expected to be consistent and acceptable for end-use.

5. Apparatus

5.1 For color measurements, a CIE-conforming diffuse geometry instrument capable of making reflectance measurements in the specular included mode is required.

[1] This practice is under the jurisdiction of ASTM Committee C14 on Glass and Glass Products and is the direct responsibility of Subcommittee C14.11 on Optical Properties.

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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 CIE – Commission Internationale de L'Eclairage, Wien, Austria, www.cie.co.at.

5.2 A fixture device is required to consistently place the sample at the reflection port.

5.3 To prevent transmitted signal from being part of the measurement, a light trap capable of being mounted behind the glass sample at the reflectance port may be required to measure partially reflective coatings.

5.4 The instrument and associated color quality software/firmware shall be capable of converting measured spectral reflectance data to CIE L*, a* b*; Hunter L, a, b; or Y *x*, *y* values calculated for CIE illuminant D65 and the CIE 1964 10 degree standard observer. (See Practice E1164.) Any of these mappings will serve as a full numerical color descriptor. (See Practice E308.) CIE Y luminosity can also serve as an over-all indicator of reflectance. For other illuminant/observer combinations, see Practice E308 for guidance in use. For effective communication of color values between sites, color measurements must be expressed in the same color scale, illuminant, and standard observer.

5.5 The expression of a tolerance in terms of rectangular, polar, or elliptical color differences shall serve to quantify the difference between target product color and lot color. (See Practice D2244.)

6. Materials

6.1 Samples are opaque or partially reflective coated glass with defined substrate, coating compositions, and thicknesses.

7. Hazards

7.1 Consult current suppliers' Material Safety Data Sheets, and local regulations for all materials used in this test method.

8. Color Instrument Calibration and Set Up Procedure

8.1 Prepare instrument for operation by following the instrument manufacturer's instructions.

8.2 Use instrument standardization to set the color instrument to the assigned values for the light trap and white tile standards supplied by the manufacturer or other suitable reference material.

8.3 To document consistency in the color instrument performance over time, it is advisable to read and record color values for an intermediate color standard and didymium filter (usually available from the manufacturer). Care should be taken to visually inspect these standards for any significant visual abrasion and replace it if warranted.

8.4 As the stability characteristics of coated and non-coated glass are generally good, the user may, at their option, read and record color values for a glass sample to document consistency in the measurement method over time. Care should be taken to visually inspect the glass sample for any significant visual abrasion and replace it if warranted.

9. Measurement Method

9.1 Place the coated or non-coated glass sample at the reflectance port. If necessary, mount a sample at the port using a fixture device, particularly if the sample is not flat.

9.2 If the sample is partially reflective and the main interest is the specular color of a coating, back the sample with a light trap to prevent any light transmitted through the sample from being retro-reflected back through the sample.

9.3 If translucent glass is being measured in reflectance, back the glass with a white tile as a constant surround.

9.4 At a minimum, scan the sample over the range of wavelengths required for measurement. Two scans with a 90º rotation of the samples between scans are preferable. If practical and possible, scan at least one other area of the sample as well.

10. Report

10.1 Report the following information:

10.1.1 Sample identification,

10.1.2 Color scale, illuminant, standard observer, instrument geometry and transmittance mode;

10.1.3 Sample preparation and presentation conditions, including number and pattern of readings averaged.

10.1.4 Average color or color difference values, or both, a product standard color to nearest hundredth of a unit.

NOTE 1—Sample preparation includes items of glass description such as the type and form (single layer versus multi-layer IG; laminated, pattern and thickness), as well as the surface preparation technique (cleaning method prior to measurement, polishing).

NOTE 2—Sample presentation includes any side or positional information; the area of view measured in each reading; the number of readings averaged and if readings were taken in a specific pattern.

10.1.5 The CIE Y value may also be reported to nearest hundredths of a unit, as an instrumental measure of the overall brightness of the glass.

11. Keywords

11.1 coatings; color; glass; reflectance