



Designation: E1348 – 22

# Standard Test Method for Transmittance and Color by Spectrophotometry Using Hemispherical Geometry<sup>1</sup>

This standard is issued under the fixed designation E1348; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method describes the instrumental measurement of the transmission properties and color of object-color specimens by the use of a spectrophotometer or spectrophotometer with a hemispherical optical measuring system, such as an integrating sphere.

1.2 This test method is generally suitable for all fully transparent specimens without regard for the specimen position relative to the transmission port of the instrument. Translucent specimens, however, must be placed flush against the transmission port of the sphere.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *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:*<sup>2</sup>

[D1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics](#)

[D2244 Practice for Calculation of Color Tolerances and](#)

[Color Differences from Instrumentally Measured Color Coordinates](#)

[E179 Guide for Selection of Geometric Conditions for Measurement of Reflection and Transmission Properties of Materials](#)

[E284 Terminology of Appearance](#)

[E308 Practice for Computing the Colors of Objects by Using the CIE System](#)

[E805 Practice for Identification of Instrumental Methods of Color or Color-Difference Measurement of Materials](#)

[E1164 Practice for Obtaining Spectrometric Data for Object-Color Evaluation](#)

## 3. Terminology

3.1 *Definitions:*

3.1.1 The definitions in Guide [E179](#), Terminology [E284](#), and Practice [E1164](#) are applicable to this test method.

## 4. Summary of Test Method

4.1 This test method provides a procedure for measuring the transmittance of transmitting specimens by using a spectrophotometer or spectrophotometer equipped with a hemispherical optical measuring system such as an integrating sphere.

4.2 This test method includes procedures for calibrating the instrument and for selecting specimens suitable for precision measurement.

4.3 This test method is satisfactory for all fully transparent specimens with plane and parallel surfaces. When possible, the user should select the position of the specimen in the transmission compartment to provide either essentially total or essentially regular transmittance, depending on the end use of the measured data.

4.4 Accurate measurement of translucent specimens requires that the specimen be placed flush against the transmission port of the integrating sphere (see Practice [E1164](#), 8.1.4).

4.5 Most modern spectrophotometers have the capacity to compute the color coordinates of the specimen during the measurement. When this is the case, the user of this test method must select the color scale, illuminant and observer (see the Procedure section in Practice [E308](#), Section 6).

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee [E12](#) on Color and Appearance and is the direct responsibility of Subcommittee [E12.02](#) on Spectrophotometry and Colorimetry.

Current edition approved Oct. 1, 2022. Published November 2022. Originally approved in 1990. Last previous edition approved in 2015 as E1348 – 15<sup>ε1</sup>. DOI: 10.1520/E1348-22.

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

## 5. Significance and Use

5.1 The most direct and accessible methods for obtaining the color coordinates of object colors are by instrumental measurement using spectrophotometers or colorimeters with either hemispherical or bidirectional optical measuring systems. This test method provides procedures for such measurement by transmittance spectrophotometry using a hemispherical optical measuring system.

5.2 This test method is especially suitable for measurement of the following types of specimens (see also Guide E179 and Practice E805):

5.2.1 Fully transparent specimens (free from turbidity, haze, or translucency), and

5.2.2 Translucent or hazy specimens, provided that the specimen can be placed flush against the transmission port of the integrating sphere.

5.3 This test method is not recommended for measurement of retroreflective transparent or translucent specimens, or samples that are fluorescent.

## 6. Apparatus

6.1 *Spectrophotometer or Spectrocolorimeter*, designed for the measurement of color coordinates of transmitting specimens by use of integrating-sphere geometry.

6.2 *Calibration Standards*, either supplied by the instrument manufacturer or obtained separately, as follows (see Practice E1164, Section 10):

6.2.1 *Calibration Standards*, (1) for setting or verifying zero on the photometric scale, and (2) for setting the full scale standardization if the instrument has a reflectance port.

6.2.2 *Verification Standards (recommended)*, for (1) verifying the wavelength scale, (2) verifying linearity, and (3) verifying stray light (see Practice E1164, 10.5).

## 7. Test Specimen

7.1 For highest precision and accuracy, select specimens with the following properties (see Practice E1164, Section 9):

7.1.1 High material uniformity and freedom from blemishes in the area to be measured, and

7.1.2 Specimens that have two essentially plane and parallel surfaces, and that have a standard thickness, if one is defined.

## 8. Calibration and Verification

8.1 Calibrate or verify the calibration of the following quantities (see Practice E1164, Section 10):

8.1.1 Zero setting of the transmittance scale (mandatory);

8.1.2 Calibrate the full-scale value of the transmittance scale of the instrument with no transmitting specimen in place. If the instrument has a reflectance port, place the instrument white tile or pressed-powder reflectance standard at the reflection port (mandatory). Follow the instrument manufacturer's instructions (mandatory); and

8.1.3 Wavelength scale (recommended);

8.1.4 Stray-light level (optional);

8.1.5 Linearity (optional).

NOTE 1—For maximum accuracy of measurement of translucent specimens, the white standard at the reflection port should have the same

reflectance as that of the lining of the integrating sphere.

8.2 Verify the accuracy of the measured results by measurement of a series of verification standards (recommended) (see Practice E1164, 10.5).

## 9. Procedure

9.1 When required, select the color scale, illuminant and observer to be used in the computation of color coordinates (see the Procedure section in Practice E308, Section 6).

9.2 Select settings of other options, such as wavelength range and interval, when required. Follow the instrument manufacturer's instructions or specified procedures.

9.3 Handle the specimen carefully; avoid touching the area to be measured. When necessary, clean the specimen by an agreed procedure.

9.4 For the measurement of fully transparent specimens, place the specimen in the transmission compartment of the instrument.

9.4.1 If total transmittance is desired, place the specimen flush against the transmission measurement port of the integrating sphere.

9.4.2 If regular transmittance is desired, place the specimen in the transmission compartment, but as far away from the sphere port as possible.

9.5 For the measurement of translucent specimens, place the specimen in the transmission compartment, flush against the transmission measurement port of the integrating sphere. For maximum accuracy in the measurements, the white standard at the reflection port should have the same reflectance as that of the lining of the integrating sphere (see Practice E1164, 8.1.4).

NOTE 2—When the size and centering of the light beam at the reflection measurement port of the integrating sphere can be properly adjusted according to Test Method D1003 Procedure B, it is possible to measure transmission haze accurately. A set of haze standards should be used to verify the accuracy of the measurements.

9.6 Measure the specimen, following the instrument manufacturer's instructions.

9.7 Transcribe the data required for the report, when not printed by the instrument.

## 10. Calculation

10.1 Perform any desired calculations of color coordinates that are not made automatically by the instrument (see Practice D2244 and Practice E308).

## 11. Report

11.1 Report the following information:

11.1.1 Specimen description (see Practice E1164, 12.1.1),

11.1.2 Date of measurement,

11.1.3 Instrument parameters and specimen position as selected in Section 9, and

11.1.4 Measurement results, in the form of tables of transmittance versus wavelength or color-scale values.

## 12. Precision and Bias

12.1 *Precision*—The precision estimates are composed of three additive terms. The first term represents the noise