



Designation: E179 – 17 (Reapproved 2022)

Standard Guide for Selection of Geometric Conditions for Measurement of Reflection and Transmission Properties of Materials¹

This standard is issued under the fixed designation E179; 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.

INTRODUCTION

This is a guide describing the selecting of geometric conditions of measurement of appearance attributes such as color, gloss, reflectance, opacity, and transmittance. It includes a selection of numerical scales for appearance attributes other than color.

In describing appearance, wavelength (or spectral) variability is primarily responsible for color, while geometric (or directional) selectivity is primarily responsible for gloss, luster, translucency, and like attributes. However, geometric conditions not only affect geometric variables such as gloss and transparency, but also affect color, diffuse reflectance, and transmittance. Likewise spectral conditions can affect the measurement of geometric attributes of appearance. Therefore both the spectral and geometric conditions of measurement must be identified in specifying an appearance attribute of a specimen.

This guide describes the selection of geometric conditions and as a consequence should help improve agreement in these measurements as well as providing useful guidance in resolving differences between spectral-type measurements that are related to geometry.

1. Scope

1.1 This guide is intended for use in selecting terminology, measurement scales, and instrumentation for describing or evaluating such appearance characteristics as glossiness, opacity, lightness, transparency, and haziness in terms of reflected or transmitted light. This guide does not consider the spectral variations responsible for color, but the geometric variables described herein can importantly affect instrumentally measured values of color. This guide is general in scope rather than specific as to instrument or material.

1.2 *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

- C346 Test Method for 45-deg Specular Gloss of Ceramic Materials**
- C347 Test Method for Reflectivity and Coefficient of Scatter of White Porcelain Enamels (Withdrawn 1990)³**
- C523 Test Method for Light Reflectance of Acoustical Materials by the Integrating Sphere Reflectometer (Withdrawn 1988)³**
- C584 Test Method for Specular Gloss of Glazed Ceramic Whitewares and Related Products**
- D523 Test Method for Specular Gloss**
- D1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics**
- D1455 Test Method for 60° Specular Gloss of Emulsion Floor Polish**

¹ This guide is under the jurisdiction of ASTM Committee E12 on Color and Appearance and is the direct responsibility of Subcommittee E12.03 on Geometry. Current edition approved Oct. 1, 2022. Published November 2022. Originally approved in 1961. Last previous edition approved in 2017 as E179 – 17. DOI: 10.1520/E0179-17R22.

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 The last approved version of this historical standard is referenced on www.astm.org.

- D1494 Test Method for Diffuse Light Transmission Factor of Reinforced Plastics Panels
- D1746 Test Method for Transparency of Plastic Sheet
- D1834 Test Method for 20° Specular Gloss of Waxed Paper (Withdrawn 2004)³
- D4039 Test Method for Reflection Haze of High-Gloss Surfaces
- D4061 Test Method for Retroreflectance of Horizontal Coatings
- E97 Method of Test for Directional Reflectance Factor, 45-Deg 0-Deg, of Opaque Specimens by Broad-Band Filter Reflectometry (Withdrawn 1991)³
- E284 Terminology of Appearance
- E429 Test Method for Measurement and Calculation of Reflecting Characteristics of Metallic Surfaces Using Integrating Sphere Instruments (Withdrawn 1996)³
- E430 Test Methods for Measurement of Gloss of High-Gloss Surfaces by Abridged Goniophotometry
- E808 Practice for Describing Retroreflection
- E809 Practice for Measuring Photometric Characteristics of Retroreflectors
- E810 Test Method for Coefficient of Retroreflection of Retroreflective Sheeting Utilizing the Coplanar Geometry
- E811 Practice for Measuring Colorimetric Characteristics of Retroreflectors Under Nighttime Conditions
- E991 Practice for Color Measurement of Fluorescent Specimens Using the One-Monochromator Method
- E1164 Practice for Obtaining Spectrometric Data for Object-Color Evaluation
- E1331 Test Method for Reflectance Factor and Color by Spectrophotometry Using Hemispherical Geometry
- E1348 Test Method for Transmittance and Color by Spectrophotometry Using Hemispherical Geometry
- E1349 Test Method for Reflectance Factor and Color by Spectrophotometry Using Bidirectional (45°:0° or 0°:45°) Geometry
- E1767 Practice for Specifying the Geometries of Observation and Measurement to Characterize the Appearance of Materials
- E2194 Test Method for Multiangle Color Measurement of Metal Flake Pigmented Materials
- E2539 Test Method for Multiangle Color Measurement of Interference Pigments
- F768 Test Method for Specular Reflectance and Transmittance Measurements of Optically Flat-Coated and Non-Coated Specimens (Withdrawn 1994)³

2.2 CIE Publications:⁴

- CIE Publication No. 15 Colorimetry
- CIE Publication No. 17 International Lighting Vocabulary
- CIE Publication No. 38 Radiometric and Photometric Characteristics of Materials and Their Measurement

3. Terminology

3.1 Definitions:

3.1.1 *flux (radiant)*, Φ , n —the time rate of flow of radiant energy; radiant power (Terminology E284).

3.1.2 *incident flux*, Φ_i , n —flux incident on the specimen at a specified illumination angle and aperture angle.

3.1.3 *reflected flux*, Φ_r , n —flux reflected from the specimen at a specified viewing angle and aperture angle.

3.1.4 *reference reflected flux*, $\Phi_{r,r}$, n —flux reflected from a reference standard of reflectance, illuminated and viewed in the same manner as the specimen under consideration.

3.1.5 *transmitted flux*, Φ_t , n —flux transmitted through the specimen at a specified viewing angle and field angle.

3.1.6 *reflectance*, ρ , n —ratio of the reflected flux to the incident flux defined as $\rho = \Phi_r / \Phi_i$.

3.1.7 *reflectance factor*, R , n —ratio of the reflected flux to the reference reflected flux defined as $R = \Phi_r / \Phi_{r,r}$.

3.1.8 *transmittance*, τ , n —ratio of the transmitted flux to the incident flux defined as $\tau = \Phi_t / \Phi_i$.

3.1.8.1 *Discussion*—A companion term, transmittance factor, is not normally used in the measurement of appearance attributes.

3.1.9 For other definitions see Terminology E284 and CIE Publication Nos. 17 and 38.

4. Summary of Guide

4.1 When light impinges upon a material, several phenomena can occur. Part of the light may be reflected, part may be transmitted, and part may be absorbed. This guide deals with the reflected and transmitted light and the selection of geometric conditions for its measurement.

4.2 An idealization of the light reflected and transmitted by a material is shown in Fig. 1. Fig. 2 illustrates light distributions more like those actually encountered in practice.

5. Types of Measurement Scales

5.1 *Type of Scale*—The terms defined in 3.1.6 – 3.1.8 to may be further identified by a preceding adjective, such as specular, regular, diffuse, total, or directional, thereby identifying the basis for the measurement scale. The significance of each of these adjectives is as follows:

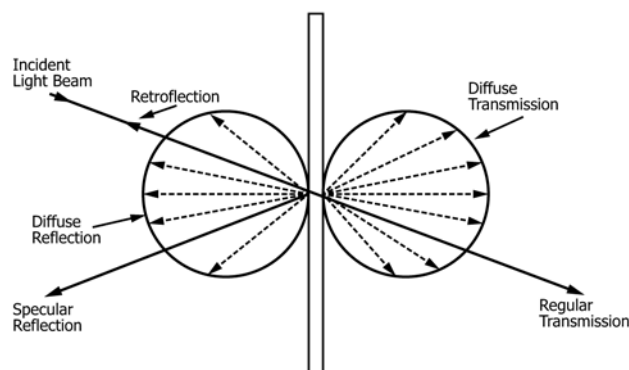


FIG. 1 Idealizations of Reflection and Transmission Phenomena, Showing Components

⁴ CIE documents may be obtained from CIE (International Commission on Illumination), <http://www.cie.co.at> or <http://www.techstreet.com>.