



Designation: E2194 – 14 (Reapproved 2021)

Standard Test Method for Multiangle Color Measurement of Metal Flake Pigmented Materials¹

This standard is issued under the fixed designation E2194; 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

Surfaces that exhibit different colors depending on the angles of illumination or sensing are said to be “gonioapparent.” Colorimetric values of reflecting gonioapparent materials are derived from spectrometric (narrow band) or colorimetric (broad band) measurements of reflectance factor, at various aspecular angles. When using spectral values, tristimulus values are computed using the CIE Standard Observer and the spectrum of the illuminant, as described in Practice E308. This test method, E2194, specifies the measurement of color observed at various aspecular angles.

1. Scope

1.1 This test method covers the instrumental requirements, standardization procedures, material standards, and parameters needed to make precise instrumental measurements of the colors of gonioapparent materials. This test method is designed to encompass gonioapparent materials; such as, automotive coatings, paints, plastics, and inks.

1.2 This test method addresses measurement of materials containing metal flake and pigments. The measurement of materials containing metal flakes requires three angles of measurement to characterize the colors of the specimen. The optical characteristics of materials containing pearlescent and interference materials are not covered by this test method.

NOTE 1—Data taken by utilizing this test method are for gonioappearance quality control purposes. This procedure may not necessarily supply appropriate data for spatial-appearance or pigment identification.

1.3 The values stated in SI units are to be regarded as standard. The values given in parentheses are for information only.

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 standard-*

ization 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

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

E1345 Practice for Reducing the Effect of Variability of Color Measurement by Use of Multiple Measurements

E1708 Practice for Electronic Interchange of Color and Appearance Data

E2539 Test Method for Multiangle Color Measurement of Interference Pigments

2.2 CIE Document:³

Publication No. 15 Colorimetry

2.3 NIST (NBS) Publication:⁴

LC-1017 Standards for Checking the Calibration of Spectrophotometers

¹ This test method is under the jurisdiction of ASTM Committee E12 on Color and Appearance and is the direct responsibility of Subcommittee E12.12 on Gonioapparent Color.

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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 (International Commission on Illumination) at www.cie.co.at or www.techstreet.com.

⁴ Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, <http://www.nist.gov>.

2.4 ISO Publication:⁵

ISO International Vocabulary of Basic and General Terms in Metrology (VIM)

3. Terminology

3.1 Terms and definitions in Terminology E284 are applicable to this test method. See Section “Specialized Terminology on Gonioapparent Phenomena.”

3.2 Definitions:

3.2.1 Usually the term metallic refers to a metal material. However, this standard employs the alternative definition given in Terminology E284 as:

3.2.2 *metallic, adj*—pertaining to the appearance of a gonioapparent material containing metal flakes.

3.3 Definitions of metrology terms in ISO International Vocabulary of Basic and General Terms in Metrology (VIM) are applicable to this test method.

4. Summary of Test Method

4.1 This test method describes the procedures for the spectrometric and colorimetric measurement of metal flake pigmented materials. The results are reported in terms of CIE tristimulus values and other color coordinate systems. Standardization of the instrument used to measure these materials is defined. Guidelines are given for the selection of specimens and a measurement protocol given. Characterization of these materials requires measurement at a near-specular angle, a mid-specular angle and a far-specular angle. These preferred aspecular angles are 15°, 45°, and 110°.

5. Significance and Use

5.1 *Instrumental Measurement Angles*—This test method is designed to provide color data at specific measurement angles that can be utilized for quality control, color matching, and formulating in the characterization of metal flake pigmented materials.

5.2 *Materials*—This test method provides meaningful color information for metal flake pigmented materials. This test method has been tested and verified on paint and coatings, and the same principles should apply to plastics containing metallic flake. For materials containing pearlescent materials refer to Test Method E2539.

5.3 *Utilization*—This test method is appropriate for measurement and characterization of metal flake pigmented materials. These data may be used for quality control, incoming inspection, or color correction purposes.

5.4 *Specimen Requirements*—Even though a pair of specimens have the same color values at three angles, if there are differences in gloss, orange peel, texture, or flake orientation, they may not be a visual match.

NOTE 2—Information presented in this test method is based upon data taken on metallic materials coatings. Applicability of this test method to

other materials should be confirmed by the user.

6. Apparatus

6.1 *Instrument*—This test method requires measurement at multiple aspecular angles, usually accomplished by the use of a multiangle spectrometer as specified in this test method to characterize metal flake pigmented materials. Measurement with a single geometry cannot characterize the gonioappearance of these materials.

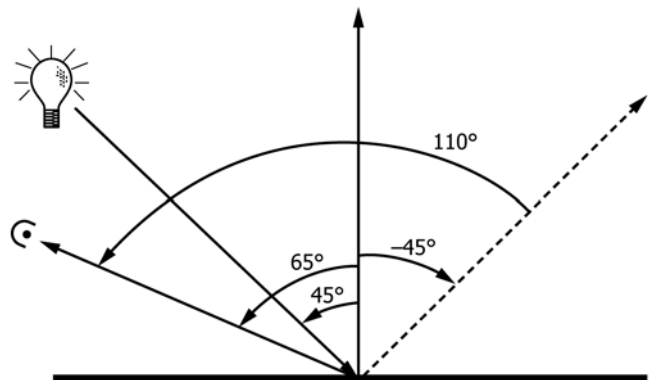
6.2 *Standardization*—A standardization plaque with assigned spectral reflectance factor or tristimulus values traceable to a national standardizing laboratory for each specified aspecular angle is required to standardize the instrument. The instrument manufacturer typically assigns the values to this plaque.

7. Geometric Conditions

7.1 *Conventional Color Measurement*—In general purpose colorimetry, the common geometry involves illuminating at 45° and sensing at 0°. This geometry is designated 45:0 (45/0). Reverse geometry has the illumination at 0° and the sensing at 45°. That is, the illuminator and sensing geometries are interchanged. This reciprocal geometry is designated 0:45 (0/45). Either geometry is used.

7.1.1 A single bi-directional geometry is specified by illumination and sensing angles with respect to the normal of the plane of the specimen. Angles are measured relative to the normal. Angles on the same side of the normal as the illumination beam are written as positive angles; those on the other side are shown as negative, as shown in Fig. 1.

7.2 *Multiangle Uniplanar Measurement*—The color of metallic materials specimens varies with the angle of view. Thus measurements must be taken at more than one aspecular angle to characterize the change of color with angle. The measurement geometry for multiangle measurements is specified by aspecular angles. The aspecular angle is the viewing angle measured from the specular direction, in the illuminator plane unless otherwise specified. The angle is considered positive when measured from the specular direction towards the illuminator axis. Thus, if the specimen is illuminated at 45° to the normal the specular reflection will be at -45° (see Fig. 1).



NOTE 1—Anormal illumination angle = 45° and anormal sensing angle = 65°; therefore, aspecular angle = 45 + 65 = 110°.

FIG. 1 Example of Illuminating and Sensing Geometry

⁵ ISO/IDE/OIML/BIPM, International Vocabulary of Basic and General Terms in Metrology, International Organization for Standardization, Geneva Switzerland, 1984.