Designation: E1767 – 11 (Reapproved 2022)

Standard Practice for Specifying the Geometries of Observation and Measurement to Characterize the Appearance of Materials[1]

This standard is issued under the fixed designation E1767; 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

The appearance of objects depends on how they are illuminated and viewed. When measurements are made to characterize appearance attributes such as color or gloss, the measured values depend on the geometry of the illumination and the instrumentation receiving light from the specimen. This practice for specifying the geometry in such applications is largely based on an international standard ISO 5/1, dealing with the precise measurement of optical density in photographic science, based on an earlier American National Standard.[2,3]

1. Scope

1.1 This practice describes the geometry of illuminating and viewing specimens and the corresponding geometry of optical measurements to characterize the appearance of materials. It establishes terms, symbols, a coordinate system, and functional notation to describe the geometric orientation of a specimen, the geometry of the illumination (or optical irradiation) of a specimen, and the geometry of collection of flux reflected or transmitted by the specimen, by a measurement standard, or by the open sampling aperture.

1.2 Optical measurements to characterize the appearance of retroreflective materials are of such a special nature that they are treated in other ASTM standards and are excluded from the scope of this practice.

1.3 The measurement of transmitted or reflected light from areas less than 0.5 mm in diameter may be affected by optical coherence, so measurements on such small areas are excluded from consideration in this practice, although the basic concepts described in this practice have been adopted in that field of measurement.

1.4 The specification of a method of measuring the reflecting or transmitting properties of specimens, for the purpose of characterizing appearance, is incomplete without a full description of the spectral nature of the system, but spectral conditions are not within the scope of this practice. The use of functional notation to specify spectral conditions is described in ISO 5/1.

1.5 *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.*

1.6 *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:*[4]

E284 Terminology of Appearance

2.2 *Other Standard:*

ISO 5/1 Photography—Density Measurements—Part 1: Terms, Symbols and Notations[5]

3. Terminology

3.1 *Definitions:*

3.1.1 The terminology used in this practice is in accordance with Terminology E284.

3.2 *Definitions of Terms Specific to This Standard:*

[1] This practice is under the jurisdiction of ASTM Committee E12 on Color and Appearance and is the direct responsibility of Subcommittee E12.03 on Geometry.

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[2] ISO1/5 Photography — Density Measurements — Part 1: Terms, symbols, and notations.

[3] ANSI PH2.36–1974 American National Standards terms, symbols, and notation for optical transmission and reflection measurements.

[4] 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.

[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

3.2.1 *anormal angle, n*—an angle measured from the normal, toward the reference plane, to the central axis of a distribution, which may be an angular distribution of flux in an incident beam or distribution of sensitivity of a receiver.

3.2.2 *aspecular angle, n*—the angle subtended at the origin by the specular axis and the axis of the receiver, the positive direction being away from the specular axis.

3.2.3 *aspecular azimuthal angle, n*—the angle subtended, at the specular axis in a plane normal to the specular axis, by the projection of the axis of the receiver and the projection of the *x*-axis on that plane, measured from the projection of the *x*-axis in a right-handed sense with respect to the specular axis.

3.2.4 *efflux, n*—radiant flux reflected by a specimen or reflection standard, in the case of reflection observations or measurements, or transmitted by a specimen or open sampling aperture, in the case of transmission observations or measurements, in the direction of the receiver.

3.2.5 *efflux, adj*—associated with the radiant flux reflected by a specimen or reflection standard, in the case of reflection observations or measurements, or transmitted by a specimen or open sampling aperture, in the case of transmission observations or measurements, in the direction of the receiver.

3.2.6 *efflux region, n*—region in the reference plane from which flux is sensed by the observer.

3.2.7 *influx, n*—radiant flux received from the illuminator at a specimen, a reflection standard, or open sampling aperture.

3.2.8 *influx, adj*—associated with radiant flux received from the illuminator at a specimen, a reflection standard, or open sampling aperture.

3.2.9 *influx region, n*—region in the reference plane on which flux is incident.

3.2.10 *optical modulation, n*—a ratio indicating the magnitude of the propagation by a specimen of radiant flux from a specified illuminator or irradiator to a specified receiver, a general term for reflectance, transmittance, reflectance factor, transmittance factor, or radiance factor.

3.2.11 *plane of incidence, n*—the plane containing the axis of the incident beam and the normal to the reference plane.

3.2.11.1 *Discussion*—This plane is not defined if the axis of the incident beam is normal to the reference plane.

3.2.12 *reference plane, n*—the plane in which the surface of a plane specimen is placed for observation or measurement, or in the case of a nonplanar specimen, the plane with respect to which the measurement is made.

3.2.13 *sampling aperture, n*—the region in the reference plane on which a measurement is made, the intersection of the influx region and the efflux region.

3.2.14 *specular axis, n*—the ray resulting from specular reflection at an ideal plane mirror in the reference plane, of the ray at the geometric axis of the incident beam.

3.2.14.1 *Discussion*—This term is applied to an incident beam subtending a small angle at the origin, not to diffuse or annular illuminators.

3.2.15 *specular direction, n*—the direction of the specular axis, the positive direction being away from the origin.

3.2.16 *uniplanar geometry, n*—geometry in which the receiver is in the plane of incidence.

3.3 *Symbols:*

de = general symbol for diffuse geometry with specular component excluded.
di = general symbol for diffuse geometry with specular component included.
E = identifies the direction of the axis of an efflux distribution on a diagram.
g = general symbol, in functional notation, for efflux geometry.
G = general symbol, in functional notation, for influx geometry.
i = subscript for incident.
I = identifies the direction of the axis of an influx distribution on a diagram.
m = subscript for half cone angle subtended by the entrance pupil of a test photometer.
M = optical modulation.
n = subscript for half cone angle subtended by a test source.
N = identifies the direction of the normal to the reference plane on a diagram.
o = point of origin of a rectangular coordinate system, in the reference plane, at the center or centroid of the sampling aperture.
r = subscript for reflected.
S = identifies the specular direction on a diagram.
t = subscript for transmitted.
x = distance from the origin, along the *x*-axis, in the reference plane, passing through point *o*.
y = distance from the origin, along the *y*-axis, in the reference plane, passing through point *o*, and normal to the *x*-axis.
z = distance from the origin, along the *z*-axis, normal to the reference plane, passing through point *o*, and having its positive direction in the direction of the vector component of incident flux normal to the reference plane.
α = aspecular angle.
β = aspecular azimuthal angle.
δ = in a pyramidal distribution, the half-angle measured in the direction normal to the plane of incidence.
ε = in a pyramidal distribution, the half-angle measured in the plane of incidence.
η = azimuthal angle, measured in the reference plane, from the positive *x*-axis, in the direction of the positive *y*-axis.
θ = anormal angle.
κ = half cone angle of a conical flux distribution.
Φ = radiant flux.
45°a = general symbol for 45° annular geometry.
45°c = general symbol for 45° circumferential geometry.

4. Summary of Practice

4.1 This practice provides a method of specifying the geometry of illuminating and viewing a material or the geometry of instrumentation for measuring an attribute of