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Standard Terminology of Appearance[1]

This standard is issued under the fixed designation E 284; 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

Appearance, including the appearance of objects, materials, and light sources, is of importance in many arts, industries, and scientific disciplines. Appearance terms are used in a wide range of ASTM standards as well as other documents of concern in standardization, testing, and specification. The purpose of this terminology standard is to define terms relating to the description of appearance.

Definitions are of two distinctly different kinds. A *descriptive* definition reports existing usage, whereas a *prescriptive* definition is an invitation to use a term in a specific way. By agreement of ASTM Committee E12 on Color and Appearance, the definitions in this terminology standard are taken to be *prescriptive* in nature. Committee E12 thereby assumes a position of leadership in usage.

Terms and definitions in several terminology standards and vocabularies other than ASTM (see References), as well as other ASTM terminology standards, have been considered for inclusion in this terminology standard. An effort has been made to achieve greater accuracy, brevity, clarity, precision, and internal consistency, and to draw distinctions that are useful in the practical measurement and specification of appearance.

Suggestions for additions or revisions to this terminology standard are welcome.

1. Scope

1.1 This terminology standard defines terms used in the description of appearance, including but not limited to color, gloss, opacity, scattering, texture, and visibility of both materials (ordinary, fluorescent, retroreflective) and light sources (including visual display units).

1.2 It is the policy of ASTM Committee E12 on Appearance that this terminology standard include important terms and definitions explicit to the scope, whether or not the terms are currently used in an ASTM standard. Terms that are in common use and appear in common-language dictionaries (see Refs **(1–4)**[2]) are generally not included, except when the dictionaries show multiple definitions and it seems desirable to indicate the definitions recommended for E12 standards.

1.3 The usage of terms describing appearance varies considerably. In some cases, different usage of a term in different fields has been noted.

2. Significance and Use

2.1 This terminology standard contains definitions of appearance terms applicable to the work of many ASTM technical committees. Its use by committees other than Committee E12 on Appearance, and its citation in the standards of such committees, is encouraged.

2.2 In this terminology standard, definitions of terms used in other ASTM standards are indicated by placing the designation of that standard in parentheses at the end of the definition. Definitions used by other organizations (see Refs **(5–7)**) are indicated similarly by placing in parentheses at the end of the definition the acronym of the organization, occasionally with the date of its terminology standard quoted. In either case, a superscript letter may be used to indicate the degree of correspondence between the definition given herein and that in the citation. Superscript *A* indicates that the two are identical; *B* that the given definition is a modification of that cited, with little difference in essential meaning; and *C* that the two differ substantially.

2.3 A further parenthetical inclusion at the end of the definition gives the revision, if after 1981, in which the definition was added to this terminology standard or last revised. An appendix at the end of this terminology standard lists changes in it since its last previous revision published in the *Annual Book of ASTM Standards*.

2.4 Where appropriate, symbols or acronyms are listed for terms in this terminology standard. Since usage varies, these listings should be considered as recommendations, not as mandatory. If a different symbol or acronym is used in another ASTM standard, this should be indicated in that standard.

2.5 In the 1990 edition of this terminology standard, a great

[1] This terminology is under the jurisdiction of ASTM Committee E12 on Color and Appearance and is the direct responsibility of Subcommittee E12.01 on Terminology.

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[2] The boldface numbers in parentheses refer to a list of references at the end of text.

many terms were relocated to conform to the recommendation of the *Form and Style for ASTM Standards*, (Blue Book) that listings be in spoken word order. In general, there are no crossreferences between the old and new listings, except where a special function is served. An example of such a special function is to list all terms relating to a given basic quantity, for example, all terms defining various sorts of angles.

2.6 This terminology standard adopts the following usage of certain word endings. The ending "ion" denotes a process, as in *reflection*; "ance" denotes a property of a specimen, as in *reflectance*; and "ity" denotes a property of the kind of material of which the specimen is composed, as in *reflectivity*. Exceptions exist, as in the common use of *illumination* and *radiation* to refer to quantities as well as processes.

3. Terminology

3.1 *Definitions:*

AATCC blue wool lightfastness standards, *n*—standard dyed-wool samples of seven grades, each step in the series representing a doubling of lightfastness.

DISCUSSION—Available from the American Association of Textile Chemists and Colorists.

abridged spectrophotometry, *n*—the measurement of reflectance factor or transmittance factor in a number of wavelength bands rather than as continuous functions of wavelength.

DISCUSSION—The wavelength bands may be isolated by the use of an array of sensors with a dispersing system or by the use of narrow-band filters.

absorbance, A**,** *n*—logarithm to the base 10 of the reciprocal of the internal transmittance T_I. $A = \log_{10}(1/T_I) = -\log_{10} T_I$. (1990) **(E 131)**[B]

absorptance α**,** *n*—the ratio of the absorbed radiant or luminous flux to the incident flux. **[CIE]**[A]

absorption, *n*—the transformation of radiant energy to a different form of energy by interaction with matter. **[CIE]**[A]

absorption coefficient, α**,** *n*—measure of the absorption of radiant energy from an incident beam (P_o) as it traverses an absorbing medium according to Bouguer's law, $P = P_o\, e^{-\alpha b}$, where b is the sample optical pathlength. (1988) **(E 131)**

absorption tinting strength, *n*—relative change in the absorption properties of a standard white material when a specified amount of an absorbing colorant, black or chromatic, is added to it. (1988a)

DISCUSSION—See the Discussion to **masstone**.

absorptivity, a**,** *n*—the absorbance divided by the product of the concentration, c, of the substance and the sample optical pathlength, b, $a = A/bc$. The units of b and c shall be specified. (1988) **(E 131)**[B]

accuracy, *n*—the closeness of agreement between a test result and an accepted reference value. (1993)

DISCUSSION—The qualitative term accuracy, when applied to a set of observed values, will be a combination of a random precision component and a systematic error or bias component. Since in routine use random components and bias components cannot be completely separated, the reported "accuracy" must be interpreted as a combination of these two elements. See **bias, precision.**

achromatic, *adj*—(*1*) *for primary light sources*, the computed chromaticity of the equal-energy spectrum. (1995)

(*2*) *for surface colors*, the color of a whitish light, serving as the illuminant, to which adaptation has taken place in the visual system of the observer. (1995)

(*3*) perceived as having no hue, that is, as white, gray, or black. **[CIE]**[B]

Adams color difference, *n*—color difference calculated by using the Adams-Nickerson opponent-color equations, based on applying the Munsell Value function to CIE 1931 tristimulus values *X, Y, Z*. (1988)

additive color mixture, *n*—superposition or other nondestructive combination of lights of different perceived colors. (1995)

additive color stimulus mixture, *n*— method of simulation that combines on the retina the actions of various color stimuli in such a manner that they cannot be perceived individually. (1995a) **[CIE]**[A]

*additive primaries***,** *n*— same as **primary color stimuli**.

ambient field, *n*—when an object or light source is viewed, the complete area beyond the surround from which light might reach the observer's eyes and influence the object's appearance. See **surround**.

*American Public Health Association (APHA) color***,** *n*—see **platinum cobalt color scale**.

*angle***,** *n*—see **aperture angle, aperture solid angle, azimuthal angle, entrance angle, observation angle, rotation angle, specular angle**.

angle of illumination, *n*—angle between the specimen normal and the illuminator axis. (1991b)

angle of incidence, *n*—the angle between a ray impinging on a surface at a point and the perpendicular to the surface at that point. In *the description of a beam*, the angle of incidence of the ray at the center of the beam.

angle of reflection, *n*—the angle between a ray reflected from a surface at a point and the perpendicular to the surface at that point.

angle of view, *n*—angle between the normal to the surface of the specimen and the axis of the receiver. (1988a)

*angle, rotation***,** *n*— see **rotation angle**.

angular subtense, *n*— *visual*, the angle subtended (by an object) at the first nodal point of the eye.

annular, *adj*—descriptor for directional illuminating (or viewing) geometry in which the illuminator provides radiation (or the receiver possesses responsivity) that is distributed continuously and uniformly throughout the 360° of azimuth of the measurement. (See also *circumferential*.) (1989) **(E 1164)**[A]

aperture angle, 2κ**,** *n*—angle subtended at a point on a specimen by the maximum dimension of the illuminator or receiver, within which the flux in a directional beam is contained. (1990)

DISCUSSION—In optics, the symbol κ is used for the half angle; hence the recommended symbol here is 2κ.

aperture mode, *n*—color seen through an aperture which prevents its association with a specific object or source.

aperture solid angle, ω, *n*—solid angle subtended at a point on the specimen, defined by the sum of rays from the illuminator or the sum of directions in which the receiver is sensitive to incoming radiation. (1990)

aperture stop, *n*—the physical diameter that limits the size of the cone of radiation that an optical system will accept from an axial point on the object. (1988) **[OSA][A]**

appearance, *n*—(*1*) the aspect of visual experience by which things are recognized. (1990)

(*2*) *in psychophysical studies*, perception in which the spectral and geometric aspects of a visual stimulus are integrated with its illuminating and viewing environment. (1993) **(E 1499)[A]**

area reflector, *n*—reflector subtending a relatively large solid angle at the observer's eye, so that the observer can clearly distinguish its size and shape. (1988)

artificial daylight, *n*—an artificial light that has a spectral power distribution approximating that of a phase of natural daylight. (1995)

aspecular, *adj*—away from the specular direction. (1995)

aspecular angle, *n*—viewing angle measured from the specular direction, in the illuminator plane unless otherwise specified. (1995a)

DISCUSSION—Positive values of the aspecular angle are in the direction toward the illuminator axis.

attributes of color—(*1*) *for the object mode of appearance*, hue, lightness, and saturation. In the Munsell system, Munsell Hue, Munsell Value, and Munsell Chroma.

(*2*) *for the illuminant or aperture mode*, hue, brightness, and saturation.

azimuthal angle, η, *n*—angle between the plane containing the axis of the illuminator (or the path of illumination) and the specimen normal and the plane containing the axis of the receiver (or the path of reception) and the specimen normal. The origin and direction of measure of the angle should be specified when required. (1990)

azimuthal viewing, *n*—deprecated term; do not use. Replace *azimuthal* by *annular* or *circumferential*. (1995a)

banding, *n*—a non-uniformity of color appearance on a scale much larger than colorant particles, characterized by a band or several nearly parallel indistinct stripes differing slightly in color from the remaining area.

basic color terms, *n*—a group of eleven color names found in anthropological surveys to be in wide use in fully developed languages: white, black, red, green, yellow, blue, brown, gray, orange, purple, pink. (1990)

beam, *n*—*in optics*, a concentrated unidirectional flow of radiant energy. (1988)

Beer's law, *n*—the absorbance of a homogeneous sample containing an absorbing substance is directly proportional to the concentration of the absorbing substance. See also **absorptivity**. (1988) **(E 131)[A]**

bias, *n*—a systematic difference between the sample mean of the measurements or test results and an accepted reference value. (1993)

DISCUSSION—Bias is the systematic component of accuracy. There may be one or more systematic error components contributing to the bias. In *appearance measurement*, the accepted reference value is usually assigned to a standard specimen; see **physical standard.**

biconical, adj— see the preferred but not equivalent term, **bidirectional,** as in bidirectional optical measuring system. (1991b)

bidirectional, adj— see **bidirectional optical measuring system.** (1991)

bidirectional optical measuring system, *n*—an optical system for measuring the reflecting or transmitting properties of specimens, wherein the illuminator and receiver each subtend small angles at the specimen surface. (1988a)

blackbody, n— see the preferred term, **full radiator**.

bleached specimen, *n*—specimen whose absorptance has been decreased by chemical or radiant means. (1987) **[TAPPI][A]**

bleeding, *n*—the unintentional transfer of coloring matter from one medium to or through another.

bloom, *n*—the scattering of light in directions near the specular angle of reflection by a deposit on or exudation from a specimen.

body color, *n*—color produced by absorption and scattering of light by colorants within a colored material. (1988)

Bouguer's law, *n*—the absorbance of a homogeneous sample is directly proportional to the thickness of the sample in the optical path. (Also known as **Lambert's [thickness] law**.) (1988) **(E 131)[A]**

brightness, *n*—(*1*) aspect of visual perception whereby an area appears to emit more or less light. (1995) **[CIE][B]** **(F 923)[B]**

(*2*) *of an object color*, combination of lightness and saturation.

(*3*) *in the textile industry*, perceived as saturated, vivid, deep, or clean.

DISCUSSION—This usage may conflict with Definition 2 in the case of dark colors.

(*4*) *of paper*, reflectance of an infinitely thick specimen (reflectivity) measured for blue light with a centroid wavelength of 457 nm under specified spectral and geometric conditions of measurement. (1987) **[TAPPI T 452][B]**

(*5*) *dyer's*, the color quality, combining lightness and saturation, that would be decreased by adding black, gray, or a complementary color to a chromatic dye.

bronzy color (or bronzing), *n*—a metallic coloration observed when viewing the light reflected at angles near the angle of specular reflection, the color usually being quite different from that observed for other directions.

calibrate, *v*—to find and eliminate systematic errors of an instrument scale or method of measurement by use of material standards and techniques traceable to an authorized national or international measurement system. (1994a)

DISCUSSION—*As defined here*, calibration is normally carried out by an instrument manufacturer. See **standardize, verify.**

candela, *cd, n*—the SI unit of luminous intensity; the luminous intensity, in a given direction, of a source that emits monochromatic radiation of frequency 540×10^{12} hertz and that has a radiant intensity in that direction of (1/683) watt per steradian.

DISCUSSION—The lone frequency of 540×10^{12} Hz mentioned in the

definition has a wavelength of 555.016 nm in standard air, which for almost all purposes can be taken to be 555 nm without affecting the accuracy of a real measurement. For sources at other frequencies (wavelengths), scale their spectral radiant intensities by the spectral luminous efficiency function, V(λ). **[CIE]**[A]

centroid wavelength, *n*—wavelength marking the center, in terms of area under a curve, of a function of wavelength weighted by multiplication with a specified response function. (1988)

DISCUSSION—In the case of (TAPPI) **brightness** (of paper) the response function is obtained by the use of a special blue tristimulus-colorimeter filter.

characterize, *v*—to specify the parameters or performance of an instrument or method of measurement. (1994)

DISCUSSION—For example, in appearance measurement, the parameters might include the geometric and spectral nature of the illuminator and the receiver, and the performance might be specified by measures of reliability, precision, and bias.

chemical luminescence, *n*—luminescence resulting from a chemical reaction. (See also **luminescence**.)

chroma, *n*—(*1*) attribute of color used to indicate the degree of departure of the color from a gray of the same lightness. See also **Munsell chroma.** (1989b)

(*2*) C^*, (in the CIE 1976 L^*, a^*, b^* or L^*, u^*, v^* system) the quantity $C^*_{ab} = (a^{*2} + b^{*2})^{1/2}$ or $C^*_{uv} = (u^{*2} + v^{*2})^{1/2}$. (1989b).

(*3*) attribute of a visual perception, produced by an object color, that permits a judgment to be made of the amount of pure chromatic color present, irrespective of the amount of achromatic color. (1995)

DISCUSSION—See also **saturation**, Definition 2.

chromatic, *adj*—perceived as having a hue; not white, gray, or black.

chromatic adaptation, *n*—changes in the visual system's sensitivities due to changes in the spectral quality of illuminating and viewing conditions. (1988)

chromaticity, *n*—the color quality of a color stimulus definable by its chromaticity coordinates, or by its dominant (or complementary) wavelength and its purity taken together. **[CIE]**[A]

chromaticity coordinates, *n*—the ratio of each of the tristimulus values of any viewed light to the sum of the three. (1995)

DISCUSSION—Chromaticity coordinates in the CIE 1931 system of color specification are designated by *x, y, z* and in the CIE 1964 supplementary system x_{10}, y_{10}, z_{10}.)

chromaticity diagram, *n*—a plane diagram in which points specified by chromaticity coordinates represent the chromaticities of lights (color stimuli). (1995) **[CIE]**[B]

chromaticness, *n*—(*1*) attribute of visual perception combining the hue and saturation. (1995)

(*2*) attribute of a visual perception according to which the color of an area appears to be more or less chromatic. (1995)

DISCUSSION—The term *colorfulness* is sometimes used as a synonym for Definition (2). **[CIE, 1970]**[B] **[CIE, 1987]**[B]

CIE, *n*—the abbreviation for the French title of the International Commission on Illumination, Commission Internationale de l'Éclairage.

CIE color-rendering index, *R*, *n*—measure of the degree to which the computed chromaticity of a CIE test color sample illuminated by a test illuminant conforms to that of the same sample illuminated by a reference illuminant. (1995)

DISCUSSION—For eight CIE test-color samples, the results are CIE special color-rendering indices, R_i, i = 1–8. The average of these is the CIE general color-rendering index R_a. **[CIE]**[C]

CIE primaries, *n*—the primary color stimuli used in the CIE system of colorimetry.

CIE spectral tristimulus values, *n*— tristimulus values or color-matching functions of the spectral components of an equal-energy spectrum in the CIE (*XYZ*) system. (1990)

DISCUSSION—The color matching functions are assigned the symbols $\bar{x}(\lambda)$, $\bar{y}(\lambda)$, $\bar{z}(\lambda)$ in the CIE 1931 colorimetric system and $\bar{x}_{10}(\lambda)$, $\bar{y}_{10}(\lambda)$, $\bar{z}_{10}(\lambda)$ in the CIE 1964 supplementary colorimetric system. **[CIE]**[B]

CIE 1931 (*x, y*) chromaticity diagram, *n*—chromaticity diagram for the CIE 1931 standard observer, in which the CIE 1931 chromaticity coordinates are plotted, with *x* as abscissa and *y* as ordinate. (1993)

CIE 1964 (x_{10}, y_{10}) chromaticity diagram, *n*—chromaticity diagram for the CIE 1964 supplementary standard observer, in which the CIE 1964 chromaticity coordinates are plotted, with x_{10} as abscissa and y_{10} as ordinate. (1993)

CIE 1976 (u', v') or (u'_{10}, v'_{10}) chromaticity diagram, *n*—chromaticity diagram in which the CIE 1976 L^* u^* v^* (CIELUV) chromaticity coordinates are plotted, with u' (or u'_{10}) as abscissa and v' (or v'_{10}) as ordinate. (1993)

DISCUSSION—These chromaticity diagrams should be used when diagrams more nearly equally visually spaced than the (*x, y*) or (x_{10}, y_{10}) *diagrams are desired.*

CIE 1931 standard colorimetric system, *n*—a system for determining the tristimulus values of any spectral power distribution using the set of reference color stimuli *X, Y, Z* and the three CIE color-matching functions $\bar{x}(\lambda)$, $\bar{y}(\lambda)$, $\bar{z}(\lambda)$ adopted by the CIE in 1931. (1987) **[CIE]**[A]

CIE standard illuminant *A*, *n*—colorimetric illuminant, representing the full radiator at 2855.6 K, defined by the CIE in terms of a relative spectral power distribution. **[CIE]**[B]

CIE standard illuminant *B*, *n*—colorimetric illuminant, representing direct sunlight with a correlated color temperature of 4874 K, defined by the CIE in terms of a relative spectral power distribution. Declared obsolete by the CIE in 1983. (1988)

CIE standard illuminant *C*, *n*—colorimetric illuminant, representing daylight with a correlated color temperature of 6774 K, defined by the CIE in terms of a relative spectral power distribution. **[CIE]**[B]

CIE standard illuminant D_{65}, *n*—colorimetric illuminant, representing daylight with a correlated color temperature of 6504 K, defined by the CIE in terms of a relative spectral power distribution. (1987) **[CIE]**[B]

CIE 1931 standard observer, *n*—ideal colorimetric observer with color matching functions $\bar{x}(\lambda)$, $\bar{y}(\lambda)$, $\bar{z}(\lambda)$ corresponding to a field of view subtending a 2° angle on the retina;

commonly called the "2° standard observer." (1988) **[CIE]**[B]

CIE standard source *A*, *n*—a gas-filled tungsten-filament lamp operated at a correlated color temperature of 2855.6 K. **[CIE]**[B]

CIE standard source *B*, *n*—standard source A combined with a specified liquid filter, to provide radiant flux with a correlated color temperature of 4874 K. Declared obsolete by the CIE in 1983. (1988)

CIE standard source *C*, *n*—standard source A combined with a specified liquid filter, to provide radiant flux with a correlated color temperature of 6774 K. (1988) **[CIE]**[B]

CIE 1964 supplementary standard colorimetric system, *n*—a system for determining the tristimulus values of any spectral power distribution using the set of reference color stimuli X_{10}, Y_{10}, Z_{10}, and the three CIE color-matching functions $\bar{x}_{10}(\lambda)$, $\bar{y}_{10}(\lambda)$, $\bar{z}_{10}(\lambda)$ adopted by the CIE in 1964. (1989) **[CIE]**[A]

CIE 1964 supplementary standard observer, *n*—ideal colorimetric observer with color matching functions $\bar{x}_{10}(\lambda)$, $\bar{y}_{10}(\lambda)$, $\bar{z}_{10}(\lambda)$ corresponding to a field of view subtending a 10° angle on the retina; commonly called the "10° standard observer." (1988) **[CIE]**[B]

CIE 1976 uniform-chromaticity-scale diagram, *n*—the uniform-chromaticity-scale diagram produced by plotting in rectangular coordinates v' against u', quantities defined as follows:

$$u' = 4X/(X + 15Y + 3Z) = 4x/(-2x + 12y + 3) \quad (1)$$
$$v' = 9Y/(X + 15Y + 3Z) = 9y/(-2x + 12y + 3)$$

for the CIE 1931 standard colorimetric system, or v'_{10} against u'_{10} for the CIE 1964 supplementary standard colorimetric system, in which case in the above formulae X_{10}, Y_{10}, Z_{10} are used instead of X, Y, Z and x_{10}, y_{10} instead of x, y. (1987) **[CIE]**[A]

CIELAB color difference, *n*—color difference calculated by using the CIE 1976 L^* a^* b^* opponent-color scales, based on applying a cube-root transformation to CIE 1931 tristimulus values X, Y, Z or CIE 1964 tristimulus values X_{10}, Y_{10}, Z_{10}. (1988)

CIELUV color difference, *n*—color difference calculated by using the CIE 1976 L^* u^* v^* opponent-color scales, based on a linear transformation of CIE chromaticity coordinates x, y, or x_{10}, y_{10} and a cube-root transformation of Y or Y_{10} to L^*, applied to CIE 1931 tristimulus values X, Y, Z or CIE 1964 tristimulus values X_{10}, Y_{10}, Z_{10}. (1988)

circumferential, *adj*—descriptor for directional illuminating (or viewing) geometry in which the illuminator provides radiation (or the receiver possesses responsivity) in many beams (or directions), normally distributed at uniform intervals throughout the 360° of azimuth of the measurement. The number and angular distribution of the beams (or directions) should be specified. (See also *annular*.) (1990) **(E 1164)**[A]

clarity, *n*—the characteristic of a transparent body whereby distinct high-contrast images or high-contrast objects (separated by some distance from the body) are observable through the body.

cmc (*l*:*c*) color difference, *n*—color difference calculated by use of the formula developed by the Colour Measurement Committee of the Society of Dyers and Colourists of Great Britain. (1990)

DISCUSSION—Based on the lightness, hue, chroma version of CIELAB, it incorporates chroma and hue-angle correction terms for improved visual spacing and variable weighting factors for lightness (l) and chroma (c) relative to hue for improved correlation depending on type of judgment (acceptability, perceptibility) and application (textiles, others).

coefficient of line retroreflection, R_M, *n—of a reflecting stripe*, the ratio of the coefficient of luminous intensity (R_I) of a retroreflecting stripe to its length (l), expressed in candelas per lux per metre ($cd \cdot lx^{-1} \cdot m^{-1}$). $R_M = (R_I/l)$. (1988) **(E 808)**[A]

coefficient of luminous intensity R_I, *n—of a retroreflector*, ratio of the luminous intensity (I) of the retroreflector in the direction of observation to the illuminance ($E_\perp$) at the retroreflector on a plane perpendicular to the direction of the incident light, expressed in candelas per lux ($cd \cdot lx^{-1}$). $R_I = (I/E_\perp)$. (1988) **(E 808)**[A]

coefficient of retroreflected luminance, R_L, *n*— ratio of the luminance, L, of a projected surface to the normal illuminance, $E_\perp$, at the surface on a plane normal to the incident light, expressed in candelas per square metre per lux ($cd \cdot m^{-2} \cdot lx^{-1}$). $R_L = (L/E_\perp)$. (1988) **(E 808)**[B]

coefficient of retroreflection, R_A, *n—of a plane reflecting surface*, the ratio of the coefficient of luminous intensity (R_I) of a plane retroreflecting surface to its area (A), expressed in candelas per lux per square metre ($cd \cdot lx^{-1} \cdot m^{-2}$). $R_A = (R_I/A)$. (1988) **(E 808)**[A]

collector, *n*—optical components, such as the cornea and lens of the eye, which guide radiant flux from a specimen being observed or measured to a sensor.

DISCUSSION—A collector and a sensor comprise a receiver.

color, *n*—(*1*) *of an object*, aspect of object appearance distinct from form, shape, size, position, or gloss that depends upon the spectral composition of the incident light, the spectral reflectance or transmittance of the object, and the spectral response of the observer, as well as the illuminating and viewing geometry. (1987)

(*2*) *perceived*, attribute of visual perception that can be described by color names such as white, gray, black, yellow, brown, vivid red, deep reddish purple, or by combinations of such names.

DISCUSSION—Perceived color depends greatly on the spectral power distribution of the color stimulus, but also on the size, shape, structure, and surround of the stimulus area, the state of adaptation of the observer's visual system, and the observer's experience with similar observations. **[TAPPI]**[A]

(*3*) *colorimetric*, characteristics of a color stimulus denoted by a colorimetric specification with three values, such as tristimulus values.

DISCUSSION—Tristimulus values are sometimes derived on a relative rather than an absolute basis. In this case they may need to be supplemented by the value of a suitable absolute photometric quantity. The appearance of colors depends not only on their absolute tristimulus

values, but also on the conditions under which they are viewed, including the nature of the surround; however, colors having the same absolute tristimulus values appear the same in identical viewing conditions. Spectrally different color stimuli can have the same absolute tristimulus values. **[TAPPI][A][CIE][B]**

colorant, *n*—dye, pigment, or other agent used to impart a color to a material. (1988)

color atlas, *n*—a collection of color samples arranged according to a color order system. (1990)

color constancy, *n*—the general tendency of the colors of an object to remain constant when the color of the illumination is changed.

color difference, *n*—(*1*) *perceived*, the magnitude and character of the difference between two colors described by such terms as redder, bluer, lighter, darker, grayer, or cleaner.

(*2*) *computed*, the magnitude and direction of the difference between two psychophysical color stimuli and their components computed from tristimulus values, or chromaticity coordinates and luminance factor, by means of a specified set of color-difference equations.

color-difference units, *n*—units of size of the color differences calculated according to various equations. Such color differences *cannot* be accurately converted between different equations by the use of average factors. (1988)

colorfulness, *n*— see **chromaticness (2)**. (1991a)

color grading, *n*—the act of identifying a specimen by a color grade or color score, which is specific to the color and the material graded.

colorimeter, *n*— see **tristimulus colorimeter, visual colorimeter**.

colorimetric purity, p_c, *n*—the fraction of spectrally pure light in an additive mixture with reference achromatic (white) light to produce a color that matches that of the color stimulus considered. (As a reference achromatic light, the CIE recommends an equal energy source for self-luminous bodies and illuminant D_{65} (daylight) for nonself-luminous bodies.) **[CIE][B]**

colorimetry, *n*—the science of color measurement.

color match, *n*—(*1*) condition existing when colors match within a specified or agreed tolerance. Sometimes called *commercial color match*. (1988a)

DISCUSSION—Compliance with tolerances can be determined instrumentally or visually. If the test for compliance is visual, physical color tolerance standards may be used for reference.

(*2*) condition existing when colors are indistinguishable; a normal observer is usually implied. Sometimes called an *exact color match*. (1988a).

color matching, *n*—procedure for providing, by selection, formulation, adjustment, or other means, a trial color that is indistinguishable from, or within specified tolerances of, a specified standard color under specified conditions. (1988a)

color-matching functions, *n*—the amounts, in any trichromatic system, of the three reference color stimuli needed to match by an additive mixture monochromatic components of an equal energy spectrum.

DISCUSSION—Symbols for these functions are lower case letters, each with a bar above and followed by the Greek letter λ in parentheses; the lower case letters corresponding to the capital letter symbols for the reference color stimuli of the system; for example, $\bar{r}(\lambda)$, $\bar{g}(\lambda)$, $\bar{b}(\lambda)$ in an *RGB* system, $\bar{x}(\lambda)$, $\bar{y}(\lambda)$, $\bar{z}(\lambda)$, in the CIE 1931 *XYZ* colorimetric system, and $\bar{x}_{10}(\lambda)$, $\bar{y}_{10}(\lambda)$, $\bar{z}_{10}(\lambda)$, in the CIE 1964 supplementary system which is based on the 10° field of view.

color measurement, *n*—process of deriving, by visual or instrumental means, a set of three numbers that describe the attributes of a color, in the form of a color notation or a colorimetric specification. (1988)

color mixture, *n*— see **additive color mixture, additive color stimulus mixture,** or **subtractive color mixture**.

color notation, *n*—the symbols used in a systematic way to designate colors.

color order system, *n*—a rational method or plan of ordering and specifying all producible object or display colors, or all within a limited domain, by means of a set of physical standards selected and displayed so as to represent adequately the whole set of such colors under consideration. (1990)

color perception, *n*—subjective impression of color, as modified by the conditions of observation and by mental interpretation of the stimulus object. (1987) **[TAPPI][A]**

color preference, *n*—preference, within a specific application, for one color over other related colors. (1988)

DISCUSSION—Examples include preferred blue for sky or green for grass in photographic color reproduction, and preferred white for bond paper.

color rendering, *n*—effect of a light source on the color appearances of objects compared to their color appearances under a reference light source. (See also **CIE color rendering index**.) (1988)

color scale, *n*— see **Gardner color scale, petroleum color scale, platinum-cobalt color scale, Saybolt color.**

color solid, *n*— see **color space**. (1987)

color space, *n*—a geometric space, usually of three dimensions, in which colors are arranged systematically.

color specification, *n*—notation or set of three color-scale values used to designate a color in a specified color system. Practical color specifications may include color tolerances as well as target color designation. (1988)

color staining, *n*—the discoloration of a material by transfer of colorant from another material. **(D 123)[C]**

color stimulus, *n*—a radiant flux capable of producing a color perception. (1995)

color stimulus function, $\phi(\lambda)$, *n*—description of a color stimulus by the spectral concentration of a radiometric quantity, such as radiance or radiant power, as a function of wavelength.

DISCUSSION—Compare with spectral power distribution. Unlike a spectral power distribution, a color stimulus function is specific to flux that is seen by the eye. **[CIE][A]**

color temperature, *n*— *of a source*, the temperature, usually expressed in kelvins, of a full radiator that would emit light of the same chromaticity as the source. (See also **correlated color temperature, distribution temperature**.) **[CIE][B]**

color tolerance, *n*—the permissible color difference between sample and specified color.

color tolerance set, *n*—a group of colored standards, usually

seven painted chips, arranged on a single card, one exhibiting a desired color, and two each exhibiting the limits of the permissible range of color variation in each of the color attributes.

DISCUSSION—An example is one desired color, two limits on Munsell value, two limits on Munsell hue, and two limits on Munsell chroma.

complementary color percepts, *n*—(*1*) pairs of color percepts, one of which is induced by the other through simultaneous contrast; (*2*) pairs of color percepts, one of which is the negative after-image of the other.

complementary colors, *n*—color stimuli that produce a specified achromatic stimulus when they are suitably mixed in an additive manner.

complementary color stimuli, *n*—pairs of color stimuli that, by additive mixture produce an achromatic stimulus.

complementary wavelength, *n*—the wavelength of a spectrally pure light that when added to the light reflected or transmitted by the specimen will produce a combination that color matches a reference achromatic (white) light.

conspicuity, *n*—the characteristics of an object that determine the likelihood that it will come to the attention of an observer. (1990)

contrast, *n*—(*1*) *objective*, the degree of dissimilarity of a measured quantity such as luminance of two areas, expressed as a number computed by a specified formula.

DISCUSSION—The following formulas for the luminance contrast between areas having luminance L_1, and L_2(where L_2 is the larger) have been adopted by the CIE:

$$C_a = \frac{L_2 - L_1}{L_1},\ C_b = \frac{L_2 - L_1}{(L_2 + L_1)/2},\ C_c = L_2/L_1 \qquad (2)$$

The following formulas are also in use:

$$C_d = L_2 - L_1,\ C_e = \frac{L_2 - L_1}{L_2},\ C_M = \frac{L_2 - L_1}{L_2 + L_1} \qquad (3)$$

If the illumination of the areas of interest is uniform and constant, the luminances are proportional to the reflectances (or transmittances) and these quantities may be used in place of luminances in these formulas. The simple ratio, $C_c = L_2/L_1$, is usually used in ASTM standards.

(*2*) *subjective*, the degree of dissimilarity in appearance of two parts of a field of view seen simultaneously or successively. **[CIE]**[B]

contrast gloss, *n*— see **luster**.

contrast ratio, *n*— see the preferred terms **contrast** or **opacity**.

correlated color temperature, *n*—*of a source*, the temperature, usually expressed in kelvins, of a full radiator that would emit light of the chromaticity most closely resembling that of the light from the source.

DISCUSSION—Correlated color temperature extends the concept of *color temperature* to any source emitting light having a chromaticity nearly, though not exactly, the same as the chromaticity of the light emitted by a full radiator at some temperature.

crazing, *n*—a network of apparent fine cracks on or beneath the surface of materials such as in transparent plastics, glazed ceramics, glass, or clear coatings.

daylight illuminant, *n*—illuminant having the same, or nearly the same, relative spectral power distribution as a phase of daylight. (1987) **[CIE]**[A]

densitometer, *n*—instrument designed for measuring optical density of a photographic negative or positive or a printed image. (1987) **[TAPPI]**[A]

densitometry, *n*—technique for measurement of optical density by use of a densitometer. (1988)

density, *n*—see **reflectance density, reflection density, transmission density,** or **transmittance density**.

detector, *n*—device to convert radiant energy into a neural signal (such as the eye) or an electrical signal (such as a phototube, photomultiplier tube, photocell, photodiode, or the like). (1988)

dielectric, *adj*—pertaining to the appearance of those materials for which the first surface reflectance is characteristic of the illuminant; compare **metal-like**. (1995)

diffuse, *adj—in optical propagation*, transmission or reflection of flux with diffusion.

diffuse reflectance, ρ_d, *n*—the ratio of the reflected flux to the incident flux, where the reflection is at all angles within the hemisphere bounded by the plane of measurement except in the direction of the specular reflection angle. (1992)

DISCUSSION—The size of the specular reflection angle depends on the instrument and the measurement conditions used. For its precise definition the make and model of the instrument or the aperture angle or aperture solid angle of the specularly reflected beam should be specified.

diffuse reflectance factor, R_d, *n*—the ratio of the flux reflected at all angles within the hemisphere bounded by the plane of measurement except in the direction of the specular reflection angle, to the flux reflected from the perfect reflecting diffuser under the same geometric and spectral conditions of measurement. (1992)

DISCUSSION—The size of the specular reflection angle depends on the instrument and the measurement conditions used. For its precise definition the make and model of the instrument or the aperture angle or aperture solid angle of the specularly reflected beam should be specified.

diffuse reflection, *n*—reflection in which flux is scattered in many directions by diffusion at or below the surface. See **diffusion**.

diffuse transmission, *n*—transmission in which diffusion occurs, independently, on a macroscopic scale, of the laws of refraction. **[CIE]**[A]

diffuse transmittance, T_d, *n*—the ratio of the flux transmitted by a specimen to the incident flux, the transmitted flux being measured at all forward angles except the regular transmission angle. (1992)

DISCUSSION—The size of the regular transmission angle depends on the instrument and the measurement conditions used. For its precise definition the make and model of the instrument or the aperture angle or aperture solid angle of the regularly transmitted beam should be specified.

diffuser, *n*—device used to alter the spatial distribution of flux by diffusion. **[CIE]**[B]

diffusion, *n*—change of the angular distribution of a beam of radiant flux by a transmitting material or a reflecting surface such that flux incident in one direction is continuously distributed in many directions, the process not conforming

(on a macroscopic scale) to the laws of Fresnel (regular) reflection and refraction and there being no change in frequency (wavelength) of the monochromatic components of the flux.

DIN color system, *n*—color order system developed for the Deutsche Industrie Normung (German Standardization Institute) to provide equality of visual spacing of colors in specified series, based on the attributes hue, saturation, and relative darkness degree. (1988)

directional, *adj*—(1) so designed that performance depends on direction or is restricted in direction; more effective in some directions than others. (1988a)

(2) referring to a beam, beam in which the flux measured is confined to directions that differ moderately from the centroid direction or axis of the beam. (E 179) (1991b)

DISCUSSION—Moderately may be defined by specifying an appropriate aperture angle.

directionality, *n*— *(1) perceived*, the degree to which the appearance of a surface changes as the surface is rotated in its own plane, under fixed conditions of illumination and viewing. (1988a)

(2) measured—(scattering indicatrix, azimuthally nonisotropic)—difference in pattern of near-specular and semidiffusely scattered light, dependent upon the azimuthal angles of the incident and viewing beams. (1987) **[CIE]**[A]

director, *n*—optical components, such as mirrors, lenses, gratings, or other objects, such as ceilings or walls, that direct radiant flux from a source to a specimen to be observed or measured.

DISCUSSION—A source and a director comprise an illuminator or irradiator. In a measuring instrument, the director may be called the "influx optics."

distinctness-of-image gloss, *n*—aspect of gloss characterized by the sharpness of images of objects produced by reflection at a surface.

distinctness of (reflected) image—see **distinctness-of-image gloss**. **(1989b)**

distortion, *n*—*optical*, a defect in an image-forming system whereby the image is not the shape of an ideal image of the object. For example, a straight pole, viewed through a window having nonplanar surfaces, may appear to have bends in it.

distribution temperature, *n*—*of a source*, temperature, usually expressed in kelvins, of the full radiator having a relative spectral power distribution in the visible region approximately the same as that of the source.

documentary standard, *n*—document, arrived at by open consensus procedures, specifying necessary details of a method of measurement, definitions of terms, or other practical matters to be standardized. (Compare **physical standard**.)

dominant wavelength, *n*—the wavelength of a spectrally pure light that, when added to a reference achromatic (white) light, will produce a combination that matches the color of a specimen light.

efflorescence, *n*—a powdery (usually white) exudation on the surface of a specimen caused by precipitation or crystallization of soluble material that has migrated to the surface. **(D 16)**[C]

eggshell, *adj*—semimatte, having a texture resembling that of the outer surface of the shell of a chicken egg. (1990) **(C 242)**[C]

electroluminescence, *n*—luminescence resulting from electrical excitation. (See also **luminescence**.)

entrance angle, β**,** *n*—*in retroreflection*, angle between the illumination axis and the retroreflector axis. (1991a)

equal-energy illuminant, *n*—illuminant having the same spectral power at all wavelengths in the specified spectral region. (1987) **[TAPPI]**[B]

equal-energy source, *n*—a source having the same radiant exitance in each constant wavelength interval in the spectral region under consideration.

excitation purity, p_e**,** *n*—the ratio of the lengths of line segments NC to ND, obtained when a straight line is drawn on the CIE chromaticity diagram from the achromatic (neutral) point (N), through the point (C) representing the color stimulus considered, to the intersection (D) with the spectrum locus or the straight boundary of nonspectral colors, as the case may be. **[CIE]**[B]

exitance, *M***,** *n*—flux leaving a surface per unit area. (1988)

face, *adj*—pertaining to viewing a specimen at an angle close to its surface normal.

face angle, *n*—the aspecular angle when a specimen is viewed close to its surface normal and illuminated near 45°, or when those angles of illumination and viewing are interchanged.

face color, *n*—the color of a material when viewed at its face angle.

DISCUSSION—This term also applies when the illuminating and viewing angles are interchanged.

fading, *n*—a change in color, usually to a lighter and less-saturated color.

field, *n*—that portion of the surface of a specimen that is illuminated by the illuminator or viewed by the receiver. (1990)

field stop, *n*—the physical diameter that limits the angular field of view of an optical system. (1988) **[OSA]**[A]

flash, *n*—appearance of a material when viewed close to the angle at which it is lightest. (1995)

flat, *adj*—(*1*) *of a coating material*, a material that is capable of imparting a finish free of gloss. (1990)

(*2*) *of a surface finish*, free of gloss. (1990)

flip—deprecated term, do not use. This term may have various meanings that are not clearly defined. (1995a)

flop, *n*—a difference in appearance of a material viewed over two widely different aspecular angles. (1995)

flop, *adj*—pertaining to the appearance of a material when viewed from a direction far from the specular angle, typically 70° or more. (1995)

flop angle, *n*—the aspecular angle when a material is viewed from a direction far from the specular, typically 70° or more. (1995)

flop color, *n*—color of a material when viewed from a specified direction far from the specular angle, typically 70° or more. (1995)

flop contrast, *n*—a measure of the degree of dissimilarity in

appearance of a specimen when it is viewed at two widely different aspecular angles.

flop index, *n*—a numerical scale of flop obtained by visual experiments. (1995)

fluorescence, *n*—photoluminescence that ceases when excitation ceases.

DISCUSSION—The time delay between absorption and emission of generally less than 10 nsec associated with fluorescence distinguishes it from phosphorescence with its generally longer time delay. See **photoluminescence** and **phosphorescence**.

fluorescent, *adj*— *(1)* exhibiting fluorescence.

(2) of a source, having a primary radiant flux emitter that excites fluorescence in a phosphor to produce light.

DISCUSSION—The primary emitter is usually a mercury glow-discharge and the spectral lines typical of this emitter are usually observed as components of the spectrum of such a source.

*fluorescent brightener***,** *n*—discouraged term for **fluorescent whitening agent**.

fluorescent illuminant, *n*—illuminant representing the spectral distribution of the radiation from a specified type of fluorescent lamp. (1988)

fluorescent whitening agent, *FWA***,** *n*—fluorescent dye or pigment that absorbs near-ultraviolet radiant flux and re-emits the power as visible light (violet-blue), thereby causing a whiter appearance when added to a yellowish-white material.

flux—see **radiant flux, luminous flux**.

FMC-2 color difference, *n*—color difference calculated by use of the Friele-MacAdam-Chickering, Version 2, equations based on the MacAdam chromaticity-difference-perceptibility ellipses and the Munsell value function. (1988)

DISCUSSION—The equations do not directly incorporate opponent-color terms, and their separation into red-green, yellow-blue, and lightness terms is at best a poor approximation.

footcandle, *n*—unit of illuminance equal to one lumen per square foot.

DISCUSSION—The preferred unit of illuminance is the SI unit *lux* (one lumen per square metre).

fractional reflectance, R_f**,** *n*—the ratio of the flux reflected from a specimen in a specified solid angle to that incident on the specimen. (1991b)

fractional transmittance, T_f**,** *n*—the ratio of the flux transmitted through a specimen in a specified solid angle to the incident flux. (1991b)

Fresnel reflection, *n*—the process by which radiant flux is reflected from an optically smooth interface between two dielectric media.

DISCUSSION—The reflectance depends on the angle of incidence, the ratio of refractive indexes of the two media, and the state of polarization of the incident beam relative to the normal to the interface.

full radiator, *n*—a thermal radiator that completely absorbs all incident radiant flux, whatever the wavelength, direction of incidence, or polarization.

DISCUSSION—This radiator has, for any wavelength, the maximum spectral concentration of radiant exitance at a given temperature. **[CIE]**[B]

Gardner color scale, *n*—a color scale for clear, light-yellow fluids, defined by the chromaticities of glass standards numbered from 1 for the lightest to 18 for the darkest.

*general indices of metamerism***,** *n*—see **indices of metamerism potential**. (1991b)

geometric metamerism, *n*—deprecated term; do not use. The phenomenon it is used to describe does not conform to the internationally accepted definitions of metamerism. Use **gonioappearance**.

glare, *n*—condition of vision in which there is discomfort or a reduction in ability to see details, objects, or both, caused by an unsuitable distribution or range of luminance, or by extreme contrasts in space. (1988) **[CIE]**[B]

glitter, *n*—the appearance attributable to brilliant reflection from many small, discrete reflecting elements.

gloss, *n*—angular selectivity of reflectance, involving surface-reflected light, responsible for the degree to which reflected highlights or images of objects may be seen as superimposed on a surface. (See also **distinctness-of-image gloss, haze** (*in reflection*), **luster, sheen, specular gloss**.)

gloss reflectance factor, R_S**,** *n*—ratio of the specularly reflected part of the (whole) flux reflected from the specimen to the flux reflected from a specified gloss standard under the same geometric and spectral conditions of measurement. (1990)

DISCUSSION—The gloss standard may be a black glass or a mirror, and may be assigned one of a variety of scale values as specified.

gloss retention, *n*—portion of original gloss retained by a specimen after treatment such as aging or abrasion under specified conditions, calculated by a specified equation. (1988)

gonioapparent, *adj*—pertaining to change in appearance with change in illumination angle or viewing angle.

gonioappearance, *n*—the phenomenon in which the appearance of a specimen changes with change in illumination or viewing angle.

DISCUSSION—Examples of gonioappearance are specimens of coatings containing flake pigments.

goniochromatic match, *n*—match between a pair of specimens that holds under all sets of angular illuminating-viewing conditions. (1995)

DISCUSSION—The specimens may or may not exhibit goniochromatism and may or may not exhibit metamerism.

goniochromatism, *n*—change in any or all attributes of color of a specimen on change in angular illuminating-viewing conditions but without change in light source or observer. (1995)

DISCUSSION—Changes associated with first-surface specular reflection are not understood to lead to goniochromatism.

goniometer, *n*—an instrument for measuring or setting angles. (1991a) **(E 809)**[A]

goniophotometer, *n*—instrument that measures flux as a function of angles of illumination or observation. (1990)

goniospectrophotometer, *n*—spectrophotometer having the capability of measuring with a variety of illuminating and

viewing angles using bidirectional geometry; also known as multi-angle spectrophotometer. (1995)

halation, *n*—(*1*) the apparent increase in size of a primary or secondary light source due to scattering of light toward the observer, the surround being significantly darker than the light source. (1995a)

(*2*) *in retroreflection,* the apparent increase in size of a retroreflector, viewed by directional illumination (for example, automobile headlights) in a dark surround. (1995a)

hardcopy, *n*—self-sustaining image on a solid substrate. See **softcopy, print,** and **transparency**.

DISCUSSION—Examples include prints and transparencies. **[ISO 3664:2000]**[C]

haze, *n—in reflection,* (*1*) scattering of light at the glossy surface of a specimen responsible for the apparent reduction in contrast of objects viewed by reflection at the surface.

(*2*) percent of reflected light scattered by a specimen having a glossy surface so that its direction deviates more than a specified angle from the direction of specular reflection. (*3*) cloudy appearance attributable to light scattering.

haze, *n—in transmission,* (*1*) the scattering of light by a specimen responsible for the apparent reduction in contrast of objects viewed through it. **(D 1003)**[B]

(*2*) the percent of transmitted light that is scattered so that its direction deviates more than a specified angle from the direction of the incident beam. **(D 883, D 1003)**[B]

Hazen color, n— see **platinum-cobalt color scale**.

hemispherical, adj— see **hemispherical optical measuring system.** (1991)

hemispherical optical measuring system, *n*—an optical measuring system for measuring the reflecting or transmitting properties of specimens, wherein either the specimen is uniformly irradiated from all directions within the hemisphere on one side of the specimen or the flux emanating from the specimen is evaluated uniformly for all directions within a hemisphere.

hiding power, *n*—(*1*) the ability of a coating material to hide the surface coated by producing a specified opacity.

(*2*) the area over which a specified volume of paint can be spread to produce a specified contrast, C_c, between areas where the substrate is black and where it is white. **(D 2805)**[B]

hue, *n*—the attribute of color perception by means of which a color is judged to be red, orange, yellow, green, blue, purple, or intermediate between adjacent pairs of these, considered in a closed ring (red and purple being an adjacent pair.) (See also **Munsell hue**.) **(D 1535)**[A]

Hunter color difference, *n*—color difference calculated by the use of the Hunter equations, based on the opponent-color coordinates, *L, a, b,* applied to CIE 1931 tristimulus values for CIE standard illuminant *C,* and by extension to the CIE 1964 standard observer and other CIE standard illuminants. (1988)

hygrochromic, *adj*—known to change color when the moisture content or relative humidity varies.

ICI, *n*—trademarked abbreviation for Imperial Chemical Industries. Do not use as the abbreviation for International Commission on Illumination; see **CIE**. (1988)

illuminance, E, E_v, *n*—luminous flux incident per unit of area.

illuminant, *n*—radiant flux that may be specified by its spectral power distribution, and that can, in illuminating objects, affect their perceived colors.

illuminant metamerism, *n*—the property of specimens having different spectral characteristics and having the same color when viewed by a normal observer under a given illuminant, but different colors when viewed under a different illuminant, other conditions remaining the same. (1991b)

illuminant mode, *n*—color seen as ascribed to a source of illumination. (1990)

illuminator, *n*—the portion of a radiometric or photometric instrument that provides the illuminating beam on the specimen, including the source, occasionally the monochromator or spectral filters, a diffuser such as an integrating sphere, if used, and associated optics. (1991)

illuminator plane, *n*—the plane containing the specimen normal and the axis of the illuminator. (1995)

incandescence, *n*—the self-emission of radiant energy in the visible spectrum due to the thermal excitation of atoms or molecules. (1988) **[IES]**

incandescent illuminant, *n*—illuminant representing the spectral distribution of radiation from an incandescent lamp of specified color temperature. (1988)

index of refraction, *n*—the numerical expression of the ratio of the velocity of light in a vacuum to the velocity of light in a substance, at a specified wavelength. (1988a) **(D 1245)**[B]

indices of metamerism potential, *n*— indices indicating the degree to which two metameric specimens may develop metamerism, derived solely from their different spectral characteristics. (1991b)

DISCUSSION—Such indices, sometimes misnamed *general indices of metamerism,* provide no information about the specimens under any conditions of mismatch.

infinite thickness, *n*—term applied to a layer of material so thick that increasing its thickness does not change its reflectance or other optical properties. (1987) **[TAPPI]**[B]

infrared, *adj*—referring to radiant flux having wavelengths longer than the wavelengths of light, usually wavelengths from about 780 nm to about 1 mm. (1991b)

integrating sphere, *n*—an optical device used either to collect flux reflected or transmitted from a specimen into a hemisphere or to provide isotropic irradiation of a specimen from a complete hemisphere, consisting of an approximately spherical cavity with apertures (ports) for admitting and detecting flux, and usually having additional apertures over which sample and reference specimens are placed and for including or excluding the specularly reflected components. (1988) **(E 903)**[B]

intensity, I_v, I_e, *n*—flux per unit solid angle. (See also **luminous intensity, radiant intensity**.) (1990)

interference filter, *n*—filter constructed of extremely thin alternate layers of high and low refractive-index material and capable of transmitting narrow spectral bands formed by constructive interference within the desired waveband and destructive interference at other wavelengths. (1987)

DISCUSSION—Filters of this type reflect rather than absorb flux not transmitted. **[TAPPI]**[B]

internal absorptance, α_i**,** *n*—ratio of the absorbed radiant or luminous flux to the flux that has entered the first surface of the layer of material. **[CIE]**[C]

internal transmittance, τ_i**,** *n*—the ratio of flux reaching the exit surface of a specimen to the flux that penetrates the entry surface.

irradiance, *E, E*$_e$**,** *n*—the radiant flux incident per unit area.

ISCC-NBS color name, *n*—two- to four-word descriptive phrase for a surface color, such as "vivid orange" or "dark grayish reddish brown," defined by sections of the Munsell color solid. Developed cooperatively by the Inter-Society Color Council and the National Bureau of Standards. (1987) **[TAPPI]**[B]

isotropic diffuser— see **Lambertian diffuser**.

*just noticeable difference***,** *n*—see **just perceptible difference**.

just-perceptible difference, *n*—color difference that is just large enough to be perceived in almost every trial. (1987) **[TAPPI]**[B]

Kubelka-Munk absorption coefficient, *K***,** *n*—for a thin layer within an isotropic absorbing and scattering material over a black backing, the limit as the layer thickness approaches zero of the fraction of the incident radiation absorbed by the layer, divided by its thickness. (1988)

Kubelka-Munk scattering coefficient, *S***,** *n*—for a thin layer within an isotropic scattering and absorbing material over a black backing, the limit as the layer thickness approaches zero of the fraction of the incident radiation scattered (reflected) by the layer, divided by its thickness. (1988)

Kubelka-Munk theory, *n*—phenomenological turbid-medium theory relating the reflectance and transmittance of scattering and absorbing materials to optical constants (*Kubelka-Munk absorption coefficient*, *Kubelka-Munk scattering coefficient*) and the concentrations of their colorants. (1988)

DISCUSSION—The basis of virtually all computer-color-matching calculations.

Lambert's law, *n*—the intensity (flux per unit solid angle) emitted in any direction from a surface varies as the cosine of the angle between the normal to the surface and the direction of the emitted flux (also called Lambert's cosine law). See **Lambertian diffuser**. (1988) **(E 491)**[B]

*Lambert's (thickness) law***,** *n*—see **Bouguer's law**.

Lambertian diffuser, *n*—ideal surface that reflects or transmits radiation completely in accordance with Lambert's cosine law. When illuminated from any direction, its radiance is the same for every direction of view. (1990)

light, *n*—(*1*) electromagnetic radiant power that is visually detectable by the normal human observer, radiant power having wavelengths from about 380 nm to about 780 nm. (1995)

(*2*) radiant power evaluated with respect to wavelength according to the CIE spectral luminous efficiency function. (1995)

light, *adj—referring to the color of a non-self-luminous body*, having a high luminous reflectance factor, as "light green" or "light gray."

lightfastness, *n*—the ability of a material to withstand color change on exposure to light.

*lightfastness standards***,** *n*—See **AATCC blue wool lightfastness standards**.

lightness, *n*—(*1*) the attribute of color perception by which a non-self-luminous body is judged to reflect more or less light. **(D 1535)**[A]

(*2*) the attribute by which a perceived color is judged to be equivalent to one of a series of grays ranging from black to white. **(D 16)**[B]

line reflector, *n*—reflector in the form of a line, the width of which subtends a very small solid angle at the observer's eye, so that the observer cannot readily distinguish its width. (1988)

Lovibond color system, *n*—a system of color specification based on the optical densities of yellow, red, and blue filter glasses required to modify light from a standard source to obtain light matching some given light.

Lovibond tintometer, *n*—instrument for evaluating the colors of materials by visual comparison with the colors of glasses of the Lovibond color system. (1987) **[TAPPI]**[A]

lumen, *lm***,** *n*— luminous flux emitted within one steradian by a point source having a spatially uniform luminous intensity of 1 candela. SI unit of luminous flux.

luminance, *L, L*$_v$**,** *n*—luminous flux in a beam, emanating from a surface, or falling on a surface, in a given direction, per unit of projected area of the surface as viewed from that direction, per unit solid angle.

luminance factor, *Y***,** *n*—ratio of the luminance of a specimen to that of a perfect diffuser, when illuminated and viewed under specified geometric conditions.

DISCUSSION—In the CIE 1931 system, this quantity is tristimulus value *Y*. (1991a) For fluorescent media, the luminance factor is the sum of two quantities, the reflection luminance factor Y_S and the fluorescence luminance factor Y_F:

$$Y = Y_S + Y_F \tag{4}$$

luminescence, *n*—emission of light ascribable to nonthermal excitation. (See also **electroluminescence**, **chemical luminescence**, and **photoluminescence**.)

*luminosity function***,** *n*—see **spectral luminous efficiency function**.

luminous, *adj*—weighted according to the spectral luminous efficiency function *V* (λ) of the CIE. (1987) **[TAPPI]**[B]

luminous efficacy, K_M**,** *n*—quotient of total luminous flux divided by total radiant flux; lumens per watt. $K_M = 683$ lm/W. (1988)

luminous flux, ϕ, ϕ_v—the time rate of flow of light energy; luminous power.

luminous intensity, *I, I*$_v$**,** *n*— the light flux per unit solid angle.

luster, *n*—the appearance characteristic of a surface that reflects more in some directions than it does in other directions, but not of such high gloss as to form clear mirror images. (1995) **(D 123)**[C]

lux, lx**,** *n*— illuminance corresponding to a luminous flux density of one lumen per square metre. SI unit of illuminance. **[CIE]**[A]

MacAdam color difference, *n*—nonspecific term for color difference calculated by using one of several equations and

methods based on MacAdam's color-difference-perceptibility ellipses or ellipsoids. (1988)

DISCUSSION—The exact method of calculation must be specified; for example, see **FMC-2 color difference**.

MacAdam limits, n— see **optimal colors**.

masstone, *n*—in paint technology, a pigment-vehicle mixture containing a single colorant only. (1988a)

DISCUSSION—At times colorants are developed that contain more than one pigment, but that are tested and used as if they contained only a single pigment. This definition is meant to include such colorants.

match, n—see color match. (1991)

match, *v*—to provide, by selection, formulation, adjustment, or other means, a trial color that is indistinguishable from, or within specified tolerances of, a specified standard color under specified conditions. (1991)

matte, *n*—lacking luster or gloss. Synonymous with "flat" in paint terminology.

memory color, *n*—color of an object that, according to the judgment of the observer, would match the color of another object previously seen by that observer. (1987) **[TAPPI]**[A]

mesopic, *adj*—pertaining to vision at intermediate levels of illumination, at which both retinal cones and retinal rods are stimulated. (1988)

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

metal-like, *adj*—pertaining to the appearance of a bare metal.

metameric, *adj*—(*1*) pertaining to spectrally different objects or color stimuli that have the same tristimulus values. (1988)

(*2*) pertaining to objects, having different spectrophotometric curves, that match when illuminated by at least one specific spectral composition and observed by a specific observer. (See also **parameric**.) (1988) **[CIE]**[B]**[TAPPI]**[B]

metamerism, *n*—property of two specimens that match under a specified illuminator and to a specified observer and whose spectral reflectances or transmittances differ in the visible wavelengths. See also **illuminant metamerism**, **observer metamerism**, **paramerism.** (1991b)

DISCUSSION—As a consequence of the required difference, the two specimens may not match under a different illuminator or to a different observer. Similar considerations apply to two lights matching to a specified observer but not to other observers.

metamerism indices, n— see **special indices of metamerism**, **indices of metamerism potential**. (1991b)

metamers, *n*—*(1)* spectrally different objects or color stimuli that have the same tristimulus values. (1988)

(2) specimens differing in spectral reflectance but having colors that match in light of one spectral composition, when viewed by one observer, but may not match in light of other spectral compositions, or when viewed by another observer. See also **paramers**. **[CIE]**[B]

mixed reflection, *n*—partly specular and partly diffuse reflection. (1988) **[CIE]**[B]

mixed transmission, *n*—a combination of diffuse and regular transmission.

modes, *n*—*of appearance*, various manners in which colors can be perceived (see also **aperture mode, illuminant mode, object mode**.)

monochromatic, *adj*—characterized by a single wavelength or, by extension, by a small range of wavelengths that can be described by stating a single wavelength. (1988) **(E 349)**[B]

monochromator, *n*—a device for isolating monochromatic radiation from a beam of radiation including a broad range of wavelengths. (1988) **(E 135)**[B]

mottle, *n*—a spotty nonuniformity of color appearance on a scale that is larger than the colorant particles, typically 1 to 10 mm.

Munsell Book of Color, *n*—current Munsell Color Company physical exemplification of the Munsell color order system, consisting of about 1600 color chips arranged in a cylindrical coordinate system of planes of constant Munsell hue on which Munsell value is displayed vertically and Munsell chroma horizontally. (1988)

Munsell chroma, *n*—an attribute of color used in the Munsell color system to indicate the degree of departure of a color from a gray of the same Munsell value, in steps that are visually approximately equal in magnitude. **(D 1535)**[A]

Munsell color system, *n*—a system of specifying colors of surfaces illuminated by daylight and viewed by an observer adapted to daylight, in terms of three attributes: hue, value, and chroma, using scales that are perceptually approximately uniform.

Munsell hue, *n*—an attribute of color used in the Munsell color system to indicate the hue of a specimen viewed in daylight. **(D 1535)**[A]

Munsell notation, *n*—(*1*) the Munsell hue, value, and chroma assigned to the color of a specimen by visually comparing the specimen to the chips in the Munsell Book of Color.

(*2*) a notation in the Munsell color system, derived from luminous reflectance *Y* and Chromaticity Coordinates *x* and *y* in the 1931 CIE system for Standard Illuminant *C*, by the use of scales defined by the Optical Society of America Subcommittee on the Spacing of the Munsell Colors. (1988) **(D 1535)**[B]

Munsell value, *n*—an attribute of color used in the Munsell color system to indicate the lightness of a specimen viewed in daylight, on a scale extending from 0 for ideal black to 10 for ideal white, in steps that are visually approximately equal in magnitude. **(D 1535)**[A]

Natural Color System, *n*—color order system based on resemblances of colors to up to four of six "elementary" colors red, yellow, green, blue, black, and white, in which the attributes of the colors are hue, chromaticness, and blackness. (1988)

NBS color difference, *n*—color difference calculated by use of the Judd-Hunter National Bureau of Standards equations, which are unique in including terms taking account of (*1*) the masking effect of gloss on the detection of color differences and (*2*) the relative importance of chromaticness and lightness in a particular viewing arrangement, such as variation in the separation between the two specimens compared. (1988)

near-specular, *adj*—pertaining to the appearance of a material when viewed from a direction close to the specular angle, typically within 25°. (1995)

near-specular angle, *n*—the aspecular angle when a material

is viewed close to the specular direction, typically within 25°. (1995)

near-specular color, *n*—color of a material when viewed at a specified near-specular angle. (1995)

neutral, *adj*—achromatic or without hue. (1987) **[TAPPI]**[B]

nonchromatic, adj— see **achromatic.**

nuance, *n*—a two-dimensional attribute that distinguishes among colors having the same hue. (1990).

object mode, *n*—color seen as ascribed to an object.

observation angle, *n*—angle between the axes of the incident beam and the observed (reflected) beam, (in *retroreflection*, α, angle between the illumination axis and the observation axis). (1991a)

observer metamerism, *n*—the property of specimens having different spectral characteristics and having the same color when viewed by one observer, but different colors when viewed by a different observer under the same conditions.

opacity, *n*—(*1*) *optical*, the ability of a specimen to prevent the transmission of light; the reciprocal of the transmittance factor.

(*2*) *paper backing*, the ability of a sheet of paper to hide a surface behind and in contact with it, expressed as the ratio of the reflectance factor $R_b$when the sheet is backed by a black surface to the reflectance factor R_∞ when it is backed by a pile of sheets of the same kind, and of such number that further addition of sheets does not affect the measured opacity.

(*3*) *white backing*, the ability of a thin film or sheet of material, such as paint or paper, to hide a surface behind and in contact with it, expressed as the ratio of the reflectance factor R_b when the material is backed by a black surface to the reflectance factor R_w when it is backed by a white surface (usually having a reflectance factor of 0.89). **(D 16)**[C] **[ISO]**[B] **[TAPPI]**[C]

opacity (printing), *n*— See **opacity** (*2*) *paper backing*.

opaque, *adj*—transmitting no optical radiation. (1990)

opponent-color scales, *n*—scales that denote one color by positive scale values, the neutral axis by zero value, and an approximately complementary color by negative scale values. Common examples include scales that are positive in the red direction and negative in the green direction (CIE *a**, Hunter *a*) and scales that are positive in the yellow direction and negative in the blue direction (CIE *b**, Hunter *b*). (1988)

optical brightener, *n*—discouraged term for **fluorescent whitening agent.**

optical density, *n*— see **reflectance density, reflection density, transmission density, transmittance density.**

optimal colors, *n*—object colors having the maximum possible luminance factor for each chromaticity. (1988)

orange peel, *n*—the appearance of irregularity of a surface resembling the skin of an orange. **(C 286, C 242)**[C]

OSA-UCS color system, *n*—Optical Society of America Uniform Color Scales color order system based on equality of visual spacing, which uses the opponent-color scales $\pm L$ (lightness), $\pm j$ (yellowness-blueness), and $\pm g$ (greenness-redness). (1988)

OSA-UCS samples, *n*—current Optical Society of America physical exemplification of the OSA-UCS color system, consisting of about 550 samples displayed on a face-centered-cubic lattice such that each interior sample has 12 nearest neighbors at equal intervals from it. (1988)

Ostwald color system, *n*—color order system in which colors are specified in terms of the attributes hue, blackness, and whiteness, and are spaced according to the results of spinning-disk mixing of specified amounts of ideal black, white, and maximally chromatic samples. (1988)

parameric, *adj*—pertaining to specimens having different spectrophotometric curves that produce approximately the same color sensation under the same illuminating and viewing conditions. (See also **metameric**.) (1989b)

paramerism, *n*—phenomenon in which specimens having different spectrophotometric curves produce approximately the same color sensation under the same illuminating and viewing conditions. (See also **metamerism**.) (1989b)

paramers, *n*—specimens having different spectrophotometric curves that produce approximately the same color sensation under the same illuminating and viewing conditions. (See also **metamers**.) (1989b)

pearlescent, *adj*—exhibiting various colors depending on the angles of illumination and viewing, as observed in mother-of-pearl. (1995a)

percept, *n*—the result of the process of perception. (1995)

perception, *n*—See **visual perception.** (1995)

perfect reflecting diffuser—ideal reflecting surface that neither absorbs nor transmits light, but reflects diffusely, with the radiance of the reflecting surface being the same for all reflecting angles, regardless of the angular distribution of the incident light. (1990)

perfect transmitting diffuser, *n*— ideal transmitting specimen that neither absorbs nor reflects light, but transmits diffusely, with the radiance of the specimen being the same for all transmitting angles, regardless of the angular distribution of the incident light. (1990)

petroleum color scale, *n*—a color scale for petroleum products, defined by 16 glass standards of specified luminous transmittance and chromaticity, graduated in steps of 0.5 from 0.5 for the lightest color to 8.0 for the darkest.

phosphorescence, *n*—photoluminescence that continues after excitation ceases.

DISCUSSION—Phosphorescence is distinguished from fluorescence by a time delay generally greater than 10 nsec. Phosphorescence should not be confused with luminescence due to radioactivity. See **photoluminescence** and **fluorescence**.

photocell, photodetector, photodiode, phototube, *n*—See **detector**.

photochromism, *n*—a reversible change in color of a specimen due to exposure to light (or other radiant flux) without appreciable heating of the specimen.

photoluminescence, *n*—luminescence produced by the absorption of radiant flux; distinguished from ordinary reflection by a time delay and, usually, a shift toward longer wavelengths. See **fluorescence** and **phosphorescence**.

photometer, *n*—an instrument for measuring light.

photometric, *adj*—pertaining to measurement of quantities in which radiation is evaluated according to the spectral luminous efficiency function $V(\lambda)$. (1990)

DISCUSSION—While this definition is basic, the root word is widely

used loosely to mean pertaining to radiant quantities, as in **spectrophotometric** and related terms. **[CIE]**[C]

photometry, *n*—the measurement of quantities associated with light, that is, radiation evaluated according to its visual effect, by weighting with the CIE spectral luminous efficiency function $V(\lambda)$. (1988) **(E 349)**[B]

photopic, *adj*—(*1*) pertaining to vision at sufficiently high levels of illumination that only the retinal cones are stimulated. (1988)

(*2*) pertaining to detectors with spectral responsivity weighted according to the CIE spectral luminous efficiency function $V(\lambda)$. (1988)

physical standard, *n*—stable specimen having a value of a physical quantity assigned by accurate measurements under specified conditions, usually in a standards laboratory.

Planckian locus, *n*—locus in a chromaticity diagram that represents the chromaticities of the radiation of Planckian radiators at different temperatures. (1987) **[CIE]**[A]

Planckian radiator, *n*— See **full radiator**.

plane, *adj*—having a flat, smooth surface with no significant variations such as elevations or depressions. (1993)

platinum-cobalt color scale, *n*—a color scale for clear, light-yellow liquids, defined by specified dilutions of a platinum-cobalt stock solution, ranging from 5 for the lightest color to 500 for the darkest.

DISCUSSION—(The scale has been extended to 2000 for some purposes.)

point reflector, *n*—reflector subtending a very small solid angle at the observer's eye, so that the observer cannot readily distinguish its size or shape. (1988)

port, *n*—an opening or aperture in an integrating sphere. (1988)

precision, *n*—the closeness of agreement between test results obtained under prescribed conditions. See also **repeatability, reproducibility.** (1993)

DISCUSSION—Precision is the random component of accuracy.

primary color stimuli, *n*—three selected colored lights used to specify the color of any light presented by the amounts of the three that must be mixed additively to produce light matching the light presented.

DISCUSSION—Any three colored lights may serve as primaries provided no one of them can be matched by a mixture of the other two. To achieve the maximum gamut of colors by additive mixture, saturated red, green, and blue primaries are commonly used.

primary colorants, *n*—a small number of colorants (dyes or pigments) that may be mixed subtractively to produce a large gamut of colors.

DISCUSSION—The most common primary colorants are yellow, magenta (purplish red), and cyan (greenish blue) in color.

primary light source, *n*—surface of an object emitting light produced by a transformation of energy. (1987) **[CIE]**[A]

primary standard, *n*—a physical standard calibrated by an absolute method.

DISCUSSION—An absolute method of measurement is a method in which the magnitude of a physical quantity is derived, in a simple way, from measurements of length, mass, time, or other basic physical quantities and from the constants in the accepted theoretical relationships among the quantities involved.

print, *n*—in still photography, printing, and digital imaging, an image, usually on paper, to be viewed by reflected light.

DISCUSSION—This sense of the term is commonly used to distinguish the image so defined from a transparency; see **transparency**. Photographic, graphic arts, and digital printing process are also used to make transparencies, and that is what they are usually called. In motion-picture technology, reproductions of original negatives or transparencies are called "prints," even though they are intended for viewing or reproduction by transmitted light, and those distributed for showing are called "distribution prints." **[ISO 3664:2000]**[C]

product standard, *n*—material having a color designated as standard for a specified product. (1990)

propagance, *n*—ratio of propagated flux to incident flux; a general term that includes the results of reflection, transmission, and similar effects that modify the flux in a beam. (1988)

psychophysics, *n*—the study of the functions relating the physical measurements of stimuli and the sensations and perceptions the stimuli evoke.

purity, *n*—See **colorimetric purity, excitation purity**.

radiance, L, L_e, *n*—radiant flux in a beam, emanating from a surface, or falling on a surface, in a given direction, per unit of projected area of the surface as viewed from that direction, per unit of solid angle.

radiance factor, β, β_e, *n*—ratio of the radiance from a point on a specimen, in a given direction, to that from the perfect reflecting or transmitting diffuser, similarly irradiated and viewed. (1988)

DISCUSSION—For fluorescent media, the radiance factor is the sum of two quantities, the reflection radiance factor β_S and the fluorescence radiance factor β_F: $\beta_e = \beta_S + \beta_F$. [CIE Publication 17.4, 1987.]

radiant, *adj*—pertaining to electromagnetic radiation, with the contributions at all wavelengths weighted equally. (1988)

radiant energy, *n*—energy transmitted as electromagnetic radiation. **(E 135)**[A]

radiant exposure, *n*—time integral of the irradiance at a given point over a specified time interval. (1989b) **[CIE]**[B]

radiant flux, Φ, *n*—the time rate of flow of radiant energy; radiant power.

radiant intensity, I, I_e, *n*—the radiant flux per unit solid angle.

radiometric, *adj*—pertaining to measurement of quantities associated with radiant energy. (1990) **[CIE]**[C]

radiometry, *n*—measurement of quantities associated with radiation. (1988) **(E 349)**[A]

receiver, *n*—the portion of a photometric instrument that receives the viewing beam from the specimen, including a collector such as an integrating sphere, if used, often the monochromator or spectral filters, the detector, and associated optics and electronics. (1988a)

receiver plane, *n*—the plane containing the specimen normal and the axis of the receiver. (1995)

receptor, *n*—see **receiver**.

reference standard, *n*—a physical standard used to calibrate a group of laboratory standards.

reflectance, ρ, *n*—ratio of the reflected radiant or luminous

flux to the incident flux in the given conditions. (1989b)

DISCUSSION—The term *reflectance* is often used in a general sense or as an abbreviation for *reflectance factor*. Such usage may be assumed unless the above definition is specifically required by the context. **[CIE]**[A]

reflectance density, D_ρ**,** *n*—the negative logarithm to base ten of the reflectance. **[ANSI PH2.36]**[A]

reflectance factor, *n*—ratio of the flux reflected from the specimen to the flux reflected from the perfect reflecting diffuser under the same geometric and spectral conditions of measurement. (1988) **[CIE]**[B]

reflection, *n*—*of radiant energy*, the process by which radiant energy is returned from a material or object. See also **diffuse reflection, mixed reflection, specular reflection.**

reflection density, D_R**,** **n**—the negative logarithm to base ten of the reflectance factor. **[ANSI PH2.36]**[A]

reflectivity, ρ_∞ **,** R_∞—the reflectance of a material represented by a specimen so thick that further increase in thickness does not significantly change the reflectance. (1987)

reflectometer, *n*—instrument for the measurement of quantities pertaining to reflection. (1988) **(E 349)**[A]

reflectometry, *n*—technique for measurement of reflectance or reflectance factor. (1987) **[TAPPI]**[A]

*reflector***,** *n*— See **area reflector, line reflector, point reflector.**

refraction, *n*—change in the direction of propagation of radiation determined by change in the velocity of propagation in passing from one medium to another. (1988) **(E 349)**[A]

regular, *adj*—denoting flux reflected or transmitted without diffusion in accordance with the laws of optics. (1988)

DISCUSSION—The adjective *specular* is usually restricted to regular reflection at the specular angle.

*regular reflection***,** *n*— see the preferred term, **specular reflection.**

regular transmission, *n*—transmission without diffusion. **[CIE]**[A]

regular transmittance, τ_r**,** *n*—ratio of undiffused transmitted flux to incident flux.

regular transmittance factor, T_r**,** *n*—the ratio of the flux transmitted by a specimen and evaluated by a receiver to the flux passing through the same optical system and evaluated by the receiver when the specimen is removed from the system.

DISCUSSION—In some cases, this quantity is practically identical to the transmittance, but it may differ considerably. It exceeds unity if the system is such that the specimen causes more light to reach the receiver than would in its absence.

related color, *n*—color perceived to belong to an area seen in relation to other colors. (1991b) **[CIE, 1987]**[A]

repeatability, *n*—the closeness of agreement between the results of successive measurements of the same test specimen, or of test specimens taken at random from a homogeneous supply, carried out on a single laboratory, by the same method of measurement, operator, and measuring instrument, with repetition over a specified period of time. See also **reproducibility.** (1993)

DISCUSSION—With specification of the time periods involved, this definition is applicable to both short-term and long-term repeatability. (1994)

reproducibility, *n*—the closeness of agreement between the results of successive measurements of the same test specimen, or of test specimens taken at random from a homogeneous supply, but changing conditions such as operator, measuring instrument, laboratory, or time. The changes in conditions must be specified. See also **repeatability.** (1993)

responsivity, *s***,** *n*—quotient of the output of a detector *Y* by its input *X*: $s = Y/X$. (See also **spectral responsivity**.) (1990) **[CIE]**[B]

retroreflection, *n*—reflection in which the reflected rays are preferentially returned in directions close to the opposite of the direction of the incident rays, this property being maintained over wide variations of the direction of the incident rays. (1990) **[CIE, 1982]**[B]

retroreflectivity, *n*—property of a material or device in which, when directionally irradiated, the reflected rays are preferentially returned in directions close to the opposite of the direction of the incident rays, this property being maintained over wide variations in the direction of the incident rays. (1993)

retroreflector, *n*—a reflecting surface or device from which, when directionally irradiated, the reflected rays are preferentially returned in directions close to the opposite of the direction of the incident rays, this property being maintained over wide variations of the direction of the incident rays. (1990) **[CIE, 1982]**[B]

retroreflector axis, *n*—a designated line segment from the retroreflector center that is used to describe the angular position of the retroreflector. (1988) **(E 808)**[B]

retroreflector center, *n*—a point on or near a retroreflector that is designated to be the center of the device for the purpose of specifying its performance. (1988) **(E 808)**[B]

rotation angle, ϵ**,** *n*—angle indicating the orientation of the specimen when it is rotated about a selected axis fixed in it (for plane specimens, usually the specimen normal); *in retroreflection*, angle indicating orientation after rotation about the retroreflector axis. (1990) **(E 808)**[C]

sample, *n*—a small part or portion of a material or product intended to be representative of the whole.

saturation, *s***,** *n*—(*1*) *in the CIE 1976 L*, u*, v** system, the quotient of the CIE 1976 *u, v,* chroma C^*_{uv} by the CIE 1976 lightness *L**, $s = C^*_{uv}/L^*$. (1990)

(*2*) attribute of a visual sensation that permits a judgment to be made of the proportion of pure chromatic color in the total sensation. (See also **chroma** (*3*).) (1990) **[CIE, 1970]**[A]

Saunderson correction, *n*—mathematical expression relating, in turbid medium theory, the fluxes on opposite sides of a boundary at which there is a change in refractive index. (1991b)

DISCUSSION—Used in computer color matching calculations.

Saybolt color, *n*—an empirical definition of the color of a clear petroleum liquid based on a scale of −16 (darkest) to +30 (lightest).

DISCUSSION—The number is derived by finding the height of a column of liquid sample which is visually just lighter than the

appropriate one of three glass standards and referring to Table 1 of ASTM D 156, Test Method for Saybolt Color of Petroleum Products (Saybolt Chromometer Method).[3]

scale, *n*—a defined arrangement of the elements of a set of stimuli or responses.

scale, *v*—to assess the content of one or more appearance attributes in the members of a set of stimuli.

scattering, *n*—the process by which light or other electromagnetic radiant flux passing through matter is redirected over a range of angles.

scattering tinting strength, *n*—relative change in the scattering properties of a standard black material (with no scattering colorant present) when a specified amount of a white or chromatic scattering colorant is added to it. (1988a)

DISCUSSION—See the Discussion to **masstone**.

scotopic, *adj*—pertaining to vision at sufficiently low levels of illumination that only the retinal rods are stimulated. (1988)

secondary light source, *n*—surface or object that is not self-emitting but receives light and re-directs it, at least in part, by reflection or transmission. (1987) **[CIE]**[A]

shade, *n*—(*1*) a color produced by a dye or pigment mixture including black dye or pigment. See also **shade,** *v*; **tint,** *n*; **tint,** *v*.

(*2*) an expression of color difference from a reference dyeing such that another dye must be added to produce a match.

(*3*) a color slightly different from a reference color.

DISCUSSION—"Shade" is the most overworked of the terms used to describe colors and color differences in terms of colorant technology, sometimes even being used as a general synonym for "color."

shade, *v*—to adjust the color of a test specimen to be a closer color match to the standard. See also **shade**, *n*; **tint**, *v*; **tint**, *n*. (1990)

shade sorting, *n*—process of grouping together, often by instrumental measurement, similarly colored materials so that the materials within each group may be used together in a finished product without perceived color variation. (1990)

sheen, *n*—the specular gloss at a large angle of incidence for an otherwise matte specimen.

DISCUSSION—(The usual angle for measurement is 85°.) (1988)

side-tone, *n*—appearance at the flop angle. (1995)

side-tone scattering, *n*—scattering of light in a material resulting in a milky appearance only when the specimen is viewed at the flop angle.

Snell's law, *n*—the product of the sine of the angle of refraction by the refractive index of the refracting medium is equal to the product of the sine of the angle of incidence by the index of refraction of the medium containing the incident beam. (1988) **[OSA]**[A]

softcopy, *n*—non-self-sustaining image. See **hardcopy**.

DISCUSSION—A common example is an image displayed on a computer monitor, but optical projection of a photographic transparency may also be described as producing a softcopy.

[ISO 3664:2000][C]

solid-color, *adj*—not containing flake or gonioapparent pigments.

source, *n*—an object that produces light or other radiant flux, or the spectral power distribution of that light. (See also **standard source, CIE standard source *A*, CIE standard source *B*, CIE standard source *C*.**)

sparkle, *n*—the visual contrast between the appearance of highlights on the particles of a gonioapparent pigment and their immediate surround.

special indices of metamerism, *n*— indices of degree of metamerism associated with specific changes in illuminating or viewing conditions, such as change of illuminant or change of observer. (1991b)

specific luminance, *n*— see **coefficient of retroreflected luminance**.

specimen, *n*—a piece or portion of a sample used to make a test.

specimen normal, *n*— see **surface normal**. (1991b).

spectral, *adj—(1) modifying a quantity*, descriptor that the quantity is a function of wavelength; (*2*) *for radiometric quantities*, pertaining to monochromatic radiant energy at a specified wavelength or, by extension, to radiant energy within a narrow wavelength band about a specified wavelength. **(E 349)**[B]

spectral bandwidth, Δλ, *n*—the wavelength interval, Δλ, of radiant energy leaving the exit slit of a monochromator measured at half the peak detected power. (1990) **(E 131)**[B]

spectral characteristic, *n*—the reflectance, reflectance factor, transmittance, or transmittance factor as a function of wavelength, used to characterize a specimen.

spectral luminous efficiency function, $V(\lambda)$, *n*—the relative effectiveness of radiant power to stimulate the perception of light by the normal human observer, as a function of wavelength: the function adopted as standard by the CIE.

spectral power distribution, SPD, $S(\lambda)$, *n*—specification of an illuminant by the spectral composition of a radiometric quantity, such as radiance or radiant flux, as a function of wavelength.

DISCUSSION—Compare with color stimulus function. Unlike a color stimulus function, a spectral power distribution may include invisible flux that interacts with an object to produce visible flux or otherwise influence its appearance.

spectral responsivity, $s(\lambda)$, *n—of a detector*, quotient of the detector output by the monochromatic input as a function of wavelength. **[CIE]**[B]

spectrocolorimeter, *n*—spectrophotometer, one component of which is a dispersive element (such as a prism, grating, or interference filter or wedge) that is normally capable of producing as output only colorimetric data (such as tristimulus values and derived color coordinates) but not the underlying spectral data from which colorimetric data are derived. (1988a) **(E 1164)**[A]

spectrogoniophotometer, *n*—goniophotometer having the capability of measuring as a function of wavelength; see the preferred term, **goniospectrophotometer**. (1995)

spectrograph, *n*—a spectrometer for optical radiation measurements in which the receiver system detects radiant

[3] *Annual Book of ASTM Standards*, Vol 05.01.

power simultaneously at many points across the spectral region of interest, for example by use of a photographic medium or an array-type photometric detector. (1992)

spectrometer, *n*—an instrument for measuring a specified property as a function of a spectral variable. *In optical radiation measurements*, the spectral variable is wavelength or wavenumber and the measured property is (or is related to) absorbed, emitted, reflected, or transmitted radiant power. See **spectrograph, spectrophotometer, spectroradiometer.** (1992)

spectrophotometer, *n*—a spectrometer for optical radiation measurements in which the receiver system is a photometer. See **photometric.** (1992)

DISCUSSION—A spectrophotometer is essentially a reflectance or transmittance spectrometer, utilizing either a bidirectional or a hemispherical optical measuring system. The suffix *photometer* derives from the time the light transducer used was the human eye. It is now almost always superseded by an optoelectronic receiver system.

spectrophotometry, *n*—quantitative measurement of reflection or transmission properties as a function of wavelength. (See also **abridged spectrophotometry**.)

spectroradiometer, *n*—a spectrometer for measuring emitted optical radiant power. (1992)

spectrum, *n*—the spatial arrangement of components of radiant power in order of wavelength.

spectrum locus, *n*—the locus of points on a chromaticity diagram representing chromaticities of monochromatic lights of various wavelengths.

specular, *adj*—pertaining to flux reflected from the surface of an object, without diffusion, at the specular angle. (1988)

specular angle, *n*—the angle of reflection equal and opposite to the angle of incidence. (1995)

DISCUSSION—In gonioapparent phenomena, this definition assumes an illuminator subtending a small angle.

specular gloss, *n*—(*1*) ratio of flux reflected in specular direction to incident flux for a specified angle of incidence and source and receptor angular apertures.

(*2*) perceived surface brightness associated with the luminous specular (regular) reflection of a surface. (1988) **[CIE]**[B]

specular reflection, *n*—reflection without diffusion, in accordance with the laws of optical reflection, as in a mirror.

standard, *n*—see **documentary standard, physical standard, primary standard, product standard, reference standard, transfer standard, verification standard, working standard**.

standard deviation, *n*—the most usual measure of the dispersion of observed values or results, expressed as the positive square root of the sum of the squared deviations from the sample average, divided by the degrees of freedom, usually $n - 1$, where n is the number of observed values. (1993)

standard illuminant, *n*—a luminous flux, specified by its spectral distribution, meeting specifications adopted by a standardizing organization. (See, for example, **CIE standard illuminant *A*, CIE standard illuminant *B*, CIE standard illuminant *C*, CIE standard illuminant D_{65}.**) (1990)

standardize, *v*—to adjust instrument output to correspond to a previously established calibration using one or more homogeneous specimens or reference materials. (See **calibrate, verify**). (1993)

DISCUSSION—As defined here, standardization is normally carried out by an instrument user.

standard observer, *n*—an ideal observer having visual response described by the CIE color-matching functions. (See also **CIE 1931 standard observer, CIE 1964 supplementary standard observer**.) (1990)

standard source, *n*—a source of radiant flux meeting specifications adopted by a standardizing organization. (See also **CIE standard source *A*, CIE standard source *B*, CIE standard source *C*.**) (1990)

stimulus, *n*—any action or condition that has the potential for evoking a response.

stop, *n*—any window or diaphragm that restricts the passage of light rays in an optical device. (See also **aperture stop, field stop**.) (1987) **[TAPPI]**[A]

strength, *n*—*dyer's*, the color quality that increases with an increase in the amount of dye present, other conditions remaining constant. (See also **tinting strength**.)

subtractive color mixture, *n*—mixture of absorbing media or superposition of filters so that the spectral composition of light passing through the combination is determined by simultaneous or successive absorption. (1987) **[TAPPI]**[A]

subtractive primaries, *n*—see **primary colorants**.

surface color, *n*—color perceived as belonging to the surface of a specimen, without the specimen appearing to be self-luminous. (1988)

surface normal, *n*—the direction normal or perpendicular to the surface of a plane specimen. (1991a)

surround, *n*—portion of the visual field immediately around the object or light source of interest. See **ambient field.** **[TAPPI]**[B]

texture, *n*—the visible surface structure depending on the size and organization of small constituent parts of a material; typically, the surface structure of a woven fabric. **(C 460)**[C]

thermochromism, *n*—a change in color with temperature change.

tint, *n*—a color produced by the mixture of white pigment or paint with a chromatic pigment or paint. (See also **tint**, *v*, **shade**, *n*, **shade**, *v*.)

DISCUSSION—A tint of a chromatic color is, therefore, lighter and less saturated than the chromatic color. **(D 16)**[B]

tint, *v*—to adjust the color of a test specimen to be a closer color match to the standard. (See also **tint**, *n*; **shade**, *vt*; **shade**, *n*.) (1991)

tinting strength, *n*—measure of the effectiveness with which unit quantity of a colorant alters the color of a material. (1988)

DISCUSSION—For scattering and absorbing colorants, both scattering and absorption tinting strength must be specified. (See **absorption tinting strength, scattering tinting strength**).

total reflectance, ρ, *n*—the ratio to the incident flux of the radiant or luminous flux reflected at all angles within the hemisphere bounded by the plane of measurement. (1991a)

total reflectance factor, *n*—the ratio of the radiant or luminous

flux, reflected at all angles within the hemisphere bounded by the plane of the specimen, to the flux reflected from the perfect reflecting diffuser under the same geometric and spectral conditions of measurement. (1990b)

total transmittance, τ_t**,** *n*—the ratio of the flux transmitted at all forward angles to the incidence flux.

transfer standard, *n*—a physical standard used to transfer a calibration from one instrument to another, usually from a reference instrument in a standards laboratory to an instrument in the field.

translucency, *n*—the property of a specimen by which it transmits light diffusely without permitting a clear view of objects beyond the specimen and not in contact with it.

translucent, *adj*—transmitting light diffusely, but not permitting a clear view of objects beyond the specimen and not in contact with it.

transmission, *n*— *of radiant energy*, the process whereby radiant energy passes through a material or object. (See also **diffuse transmission, mixed transmission, regular transmission**.)

transmission density, D_T**,** *n*—the negative logarithm to base ten of the transmittance factor. **[ANSI PH2.36]**[A]

transmittance, τ**,** *n*—the ratio of transmitted flux to incident flux, under specified geometric and spectral conditions. (See also **diffuse transmittance, internal transmittance, regular transmittance, total transmittance**.)

transmittance density, D_t**,** *n*—the negative logarithm to base ten of the transmittance. **[ANSI PH2.36]**[A]

transmittance factor, *T***,** *n*—ratio of the flux transmitted by the specimen to the flux transmitted by the perfect transmitting diffuser under the same geometric and spectral conditions of measurement. (1990)

transparency, *n*—(*1*) the degree of regular transmission, thus the property of a material by which objects may be seen clearly through a sheet of it.

(*2*) an image on a sheet, intended to be viewed or reproduced by light transmitted through it.

transparency illuminator, *n*—a device to permit viewing a transparency by diffusely illuminating it from the back.

transparent, *adj*—transmitting radiant energy without diffusion. (1990)

travel, *n*—a change in appearance of a material as it is viewed over a wide range of aspecular angles. (1995)

trichromatic system, *n*—system for specifying color stimuli in terms of tristimulus values based on matching colors by additive mixture of three suitably chosen reference color stimuli. (1987) **[CIE]**[A]

tristimulus colorimeter, *n*—instrument that measures psychophysical color, in terms of tristimulus values, by the use of filters to convert the relative spectral power distribution of the illuminator to that of a standard illuminant, and to convert the relative spectral responsivity of the receiver to the responsivities prescribed for a standard observer. (1989)

DISCUSSION—In some instruments, the filters may be combined into one set placed in the receiver; in such cases, caution should be observed when measuring fluorescent specimens. (1990)

tristimulus values—the amounts of three specified stimuli required to match a color. (See also **CIE spectral tristimulus values**.)

DISCUSSION—In the CIE system, they are assigned the symbols *X*, *Y*, and *Z*.

tristimulus weighting factors, $S\,\bar{x}$, $S\,\bar{y}$, $S\,\bar{z}$, *n*—factors obtained from products of the spectral power *S* of an illuminant and the spectral color matching functions $\bar{x}, \bar{y}, \bar{z}$ of an observer, usually tabulated at wavelength intervals of 10 or 20 nm, used to compute tristimulus values by multiplication by the spectral reflectance, transmittance, or radiance (or the corresponding factors) and summation. (1991a)

DISCUSSION—Proper account should be taken of the spectral band width of the measuring instrument, and normalization may be required.

turbidity, *n*—reduction of transparency of a specimen due to the presence of particulate matter. **(D 1129)**[B]**(D 1889)**[B]

ultraviolet, *adj*—referring to radiant flux having wavelengths shorter than the visible wavelengths about 10 to 380 nm. (1991)

ultraviolet-activated fluorescence, *n*— fluorescence resulting from the absorption of ultraviolet radiant flux, that is, flux with wavelengths shorter than 380 nm. (See also **visible-activated fluorescence.**)

uniform-chromaticity-scale diagram, *n*— chromaticity diagram on which all pairs of just-perceptibly different colors of equal luminance are represented by pairs of points separated by nearly equal distances. (1995) **[TAPPI]**[B]

uniform color space, *n*—schematic arrangement of colors in space in which spatial intervals between points correspond to visual differences between colors represented by those points. (1987) **[TAPPI]**[A]

*uniform diffuser***,** *n*— see **Lambertian diffuser.**

uniplanar, *adj*—descriptor for illuminating and viewing geometry in which the axes of the illuminator and the receiver and the normal to the specimen surface are in the same plane; thus directional illumination or viewing is provided by one beam, or by two beams spaced 180° apart in azimuth. The number and angular distribution of the beams should be specified. (1988a) **(E 1164)**[A]

unique hue, *n*—perceived hue that cannot be described by a hue name other than its own. (1992)

DISCUSSION—There are four unique hues: red, green, yellow, and blue. **[CIE]**[A]

*unitary hue***,** *n*—see **unique hue**.

unrelated color, *n*—color perceived to belong to an area seen in isolation from other colors. (1991b) **[CIE, 1987]**[A]

*value***,** *n*—*see* **Munsell value**.

veiling reflection, *n*—the reflection of light by an image-bearing surface, that reduces the apparent contrast of the image.

DISCUSSION—The amount of veiling reflection depends on the reflection properties of the surface and on the intensity and direction of the illumination. Common examples are overhead light reflected by a glossy printed page and window light reflected by a computer monitor or television screen. This effect is also called veiling glare.

venetian blind effect, *n*—the change in appearance of a specimen as it is rotated in its own plane, under fixed

conditions of illumination and viewing, resulting from preferential orientation of flake within the specimen.

DISCUSSION—(1) The process of spraying paint on a vertical surface in the earth's gravitational field may cause preferential orientation of the flake.

(2) When present, this change in appearance is best observed when one of two matching specimens of a material is rotated 180 degrees and compared to the other specimen that remained in the original position.

venetian-blind effect, *n—in surface coatings*, uniform change in an appearance attribute such as lightness as a directionally-illuminated specimen is rotated in its own plane.

DISCUSSION—The venetian-blind effect is thought to result from preferential orientation of flakes within a specimen, as may occur in the process of spraying paint on a vertical surface in the earth's gravitational field.

verification standard, *n*—calibrated physical standard used to verify the accuracy of calibration of measurement scales, operating characteristics, or systems responses of color-measuring instruments. (1991)

verify, *v*—to assess the overall reliability and accuracy of an instrument or method of measurement by use of material standards for which the measurable quantities have accepted values. See **verification standard**. (1993)

vignetting, *n*—loss of light rays at stops of an optical instrument, other than the aperture stop.

viewing angle, ν**,** *n—in retroreflection*, the angle between the retroreflector axis and the observation axis. (1993) **(E 808)**[A]

viewing conditions, *n*—the conditions under which a visual observation is made, including the angular subtense of the specimen at the eye, the geometric relationship of source, specimen, and eye, the photometric and spectral character of the source, the photometric and spectral character of the field of view surrounding the specimen, and the state of adaptation of the eye.

virtual metamer, *n*—set of spectral radiance factors, not based on physical samples, which provide a metameric match for a specific illuminant-observer combination.

DISCUSSION—Virtual metamers are used to test and classify illumination sources that simulate daylight according to the method provided in CIE Publication No. 51. This classification is accomplished by calculating the average of the color differences obtained for these metamers between the illumination source in question and a CIE standard illuminant. Although it may be possible to construct physical realizations of some virtual metamers, the fact that they need not be real allows greater flexibility in their design. **[ISO 3664:2000]**[B]

visible, *adj*—pertaining to that portion of the electromagnetic spectrum to which the eye is sensitive, approximately 380 to 780 nm in wavelength. (1991)

visible-activated fluorescence, *n*— fluorescence resulting from the absorption of visible radiant flux, that is, flux with wavelengths 380 to 780 nm. (See also **ultra-violet-activated fluorescence.**)

visibility, *n*—the properties and behavior of light waves and objects interacting in the environment to produce light signals capable of evoking visual sensation. (1989) **(F 923)**[A]

visibility distance, *n*—the greatest distance at which an object can be seen.

visual colorimeter, *n*—an instrument, using the eye as detector, that measures color stimuli produced by mixing one or more of at least three primary colors. (1989)

visual perception, *n*—the visual experience resulting from stimulation of the retina and the resulting activity of associated neural systems. (1994)

wavelength, λ**,** *n—of an electromagnetic wave*, the distance in the direction of propagation between nearest points at which the electric vector has the same phase. (See also **complementary wavelength, dominant wavelength**.) (1990)

DISCUSSION—The wavelength unit generally used in spectrophotometry related to colorimetry is the nanometer (nm). Unless otherwise stated, values of wavelength are generally those in air.

Weber's law, *n*—the just-perceptible increment of a stimulus is an approximately constant fraction of the stimulus magnitude over a wide range. (1995) **[OSA]**[B]

whiteness, *n*—attribute of color perception by which an object color is judged to approach the preferred white. (1995) **(D 1695)**[B]**(E 313)**[A]

whiteness index, *n*—a number, computed by a given procedure from colorimetric data, that indicates the degree of departure of an object color from a preferred white. (1990) **(E 313)**[A]

working standard, *n*—an instrument standard or laboratory standard in routine use.

yellowness, *n*—attribute of color perception by which an object color is judged to depart from colorless or a preferred white toward yellow. (1995)

DISCUSSION—Negative values of yellowness denote blueness. **(E 313)**[A]

yellowness index, *n*—a number, computed by a given procedure from colorimetric or spectrophotometric data, that indicates the degree of departure of an object color from colorless, or from a preferred white, toward yellow. **(E 313)**[B]

4. Specialized Terminology on Gonioapparent Phenomena

4.1 *Delimiting Phrase*—When a term in the specialized terminology of gonioapparent phenomena is used out of context but with the meaning assigned in this specialized vocabulary, editorially insert a generic delimiting phrase such as "*in gonioapparent phenomena*," or the equivalent, after the dash preceding the definition, to properly delimit the field of application of the term to that defined in the specialized terminology.

4.1.1 *List of Terms:*

angle of illumination
angle of incidence
angle of reflection
angle of view
annular
aperture angle
aperture solid angle
aspecular
aspecular angle
azimuthal angle
goniochromatic match
goniochromatism
goniometer
goniophotometer
goniospectrophotometer
illuminator
illuminator plane
luster
metal-like
metallic

(deprecated term)
azimuthal viewing
bidirectional
circumferential
detector
dielectric
directionality
face
face angle
face color
flash
flip
(deprecated term)
flop, *adj*
flop angle
flop color
mottle
near-specular
near-specular angle
near-specular color
observation angle
pearlescent
receiver plane
rotation angle
side-tone
side-tone scattering
solid-color
sparkle
specimen normal
spectrometer
spectrogoniophotometer
spectrophotometer
flop index
geometric metamerism
(deprecated term)
glitter
gonioappearance
gonioapparent
specular
specular angle
specular reflection
travel
uniplanar
venetian blind effect

5. Keywords

5.1 appearance; definitions; gonioapparent phenomena; terminology

APPENDIX

(Nonmandatory Information)

X1. ADDITIONS AND CHANGES SINCE THE LAST PREVIOUS REVISION

X1.1 *Terms or cross-references added since edition E 284 – 02.*

hardcopy

X1.2 *Definition changed since edition E 284 – 02.*

transparency

REFERENCES

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