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Standard Terminology Relating to Forensic Science¹

This standard is issued under the fixed designation E1732; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope

1.1 This terminology standard includes definitions of terms used in the forensic sciences.

1.2 Legal and scientific terms in common use that are generally understood or defined adequately in other readily available sources may not be included, except when dictionaries show multiple definitions and it seems desirable to indicate the definitions recommended for forensic science use.

1.3 Section A defines terms that are common to multiple areas of forensic science, whereas, the subsequent sections define terms pertaining to specific forensic science areas, as follows:

Section A: General (Common) Forensic Science Terms

The terms defined in Section A are the direct responsibility of Subcommittee E30.92, Terminology.

Section B: Criminalistics

The terms defined in Section B are the direct responsibility of Subcommittee E30.01, Criminalistics.

Section B1: Terms for Seized Drug Analysis

Section B2: Terms for Gunshot Residue (GSR) Analysis and Smokeless Powder Analysis

Section B3: Terms for Paint Analysis

Section B4: Terms for Textile, Fiber, Cord, and Tape Examination

Section B5: Terms for Glass Examination

Section C: Digital and Multimedia Evidence

The terms defined in Section C are the direct responsibility of Subcommittee E30.12, Digital and Multimedia Evidence.

Section C1: Terms for Computer Forensics

Section C2: Terms for Digital Image Processing and Multimedia Evidence Examination

Section C3: Terms for Magnetic Card Reader Examination

Section C4: Terms for Facial Image Examination

Section D: Interdisciplinary

The terms defined in Section D are the direct responsibility of Subcommittee E30.11, Interdisciplinary Forensic Science Standards.

Section E: Questioned Documents

The terms defined in Section E were formerly the direct responsibility of Subcommittee E30.02, Questioned Documents, and are currently the direct responsibility of Subcommittee E30.90, Executive Committee.

1.4 Entries listed in Sections B–E reflect only those existing in Committee E30 standards current with the date of a once yearly review of Committee E30 standards. Changes to standards or entries following this date will appear in Sections B–E after the following year's review date.

1.5 An alphabetical list of the terms defined in this standard is given in **Appendix XI**, which also identifies the section(s) in which each term is defined.

1.6 Definitions identical to those published by another standards-developing organization or ASTM committee are identified with the abbreviation of the name of the organization or the identifying document and ASTM committee; for example, ASME is the American Society of Mechanical Engineers.

1.7 In some cases different usage of a term in different fields has been noted.

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

C162 Terminology of Glass and Glass Products

D123 Terminology Relating to Textiles

D6161 Terminology Used for Microfiltration, Ultrafiltration, Nanofiltration and Reverse Osmosis Membrane Processes

E131 Terminology Relating to Molecular Spectroscopy

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E308 Practice for Computing the Colors of Objects by Using the CIE System

E456 Terminology Relating to Quality and Statistics

E860 Practice for Examining And Preparing Items That Are Or May Become Involved In Criminal or Civil Litigation

¹ This terminology is under the jurisdiction of ASTM Committee E30 on Forensic Sciences and is the direct responsibility of Subcommittee E30.92 on Terminology.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

- E1187** Terminology Relating to Conformity Assessment (Withdrawn 2006)³
- E1301** Guide for Proficiency Testing by Interlaboratory Comparisons (Withdrawn 2012)³
- E1402** Guide for Sampling Design
- E1588** Practice for Gunshot Residue Analysis by Scanning Electron Microscopy/Energy Dispersive X-Ray Spectrometry
- E1605** Terminology Relating to Lead in Buildings
- E1610** Guide for Forensic Paint Analysis and Comparison
- E1968** Guide for Microcrystal Testing in Forensic Analysis of Cocaine
- E1969** Guide for Microcrystal Testing in Forensic Analysis of Methamphetamine and Amphetamine
- E2125** Guide for Microcrystal Testing in Forensic Analysis of Phencyclidine and Its Analogues
- E2161** Terminology Relating to Performance Validation in Thermal Analysis and Rheology
- E2224** Guide for Forensic Analysis of Fibers by Infrared Spectroscopy
- E2225** Guide for Forensic Examination of Fabrics and Cordage
- E2227** Guide for Forensic Examination of Non-Reactive Dyes in Textile Fibers by Thin-Layer Chromatography
- E2228** Guide for Microscopical Examination of Textile Fibers
- E2363** Terminology Relating to Process Analytical Technology in the Pharmaceutical Industry
- E2388** Guide for Minimum Training Requirements for Forensic Document Examiners
- E2678** Guide for Education and Training in Computer Forensics
- E2710** Guide for Preservation of Charred Documents
- E2711** Guide for Preservation of Liquid Soaked Documents
- E2765** Practice for Use of Image Capture and Storage Technology in Forensic Document Examination
- E2808** Guide for Microspectrophotometry and Color Measurement in Forensic Paint Analysis
- E2809** Guide for Using Scanning Electron Microscopy/X-Ray Spectrometry in Forensic Paint Examinations
- E2882** Guide for Analysis of Clandestine Drug Laboratory Evidence
- E2916** Terminology for Digital and Multimedia Evidence Examination
- E2927** Test Method for Determination of Trace Elements in Soda-Lime Glass Samples Using Laser Ablation Inductively Coupled Plasma Mass Spectrometry for Forensic Comparisons
- E2937** Guide for Using Infrared Spectroscopy in Forensic Paint Examinations
- E2998** Practice for Characterization and Classification of Smokeless Powder
- E2999** Test Method for Analysis of Organic Compounds in Smokeless Powder by Gas Chromatography-Mass Spectrometry and Fourier Transform Infrared Spectroscopy
- E3017** Practice for Examining Magnetic Card Readers
- E3085** Guide for Fourier Transform Infrared Spectroscopy in Forensic Tape Examinations
- E3115** Guide for Capturing Facial Images for Use with Facial Recognition Systems
- E3148** Guide for Postmortem Facial Image Capture
- E3149** Guide for Facial Image Comparison Feature List for Morphological Analysis
- F2725** Guide for European Union’s Registration, Evaluation, and Authorization of Chemicals (REACH) Supply Chain Information Exchange

2.2 ISO Standards:⁴

- ISO 3534:1993** (E/F) Statistics—Vocabulary and Symbols Part 1: Probability and General Statistical Terms Part 2: Statistical Quality Control
- ISO 3534–1:2006** Statistics—Vocabulary and Symbols—Part 1: General Statistical Terms and Terms Used in Probability
- ISO 9000:2005** (E) Standard Quality Management Systems—Fundamentals and Vocabulary
- ISO Guide 2** General Terms and Their Definitions Relating to Standardizing Activities
- ISO Guide 30** Terms and Definitions Used in Connection with Reference Materials
- ISO Guide 35** Reference Materials—General and Statistical Principles for Certification
- ISO GUM** Guide to the Expression of Uncertainty in Measurement (GUM)
- ISO/IEC 7813** Information Technology—Identification Cards—Financial Transaction Cards

2.3 Other Sources:

- ANSI/NIST-ITL 1-2011** Data Format for the Interchange of Fingerprint, Facial, and Other Biometric Information⁵
- EURACHEM** *The Fitness for Purpose of Analytical Methods*, EURACHEM Working Group, English Edition
- IAAI Glossary** *Glossary of Terms Related to Chemical and Instrumental Analysis of Fire Debris*, IAAI Forensic Science Committee⁶
- IEEE 100-2000** The Authoritative Dictionary of IEEE Standards Terms, 7th Edition⁷
- IUPAC Terminology** *IUPAC Compendium of Chemical Terminology*, Second Edition, 1997
- NIST SP 800-86** Guide to Integrating Forensic Techniques into Incident Response⁵
- NIST SP 800-88** Guidelines for Media Sanitization⁵
- SWGDRUG**⁸

⁴ Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.org>.

⁵ Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, <http://www.nist.gov>.

⁶ Available from the International Association of Arson Investigators, Inc. (IAAI), 2111 Baldwin Avenue, Suite 203, Crofton, MD 21114, <https://www.firearson.com>.

⁷ Available from Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., Piscataway, NJ 08854, <http://www.ieee.org>.

⁸ Available from the Scientific Working Group for the Analysis of Seized Drugs, <http://www.swgdrug.org>.

³ The last approved version of this historical standard is referenced on www.astm.org.

as follows: *Webster's New Collegiate 7th Dictionary*; technical dictionaries; and the *Compilation of ASTM Standard Definitions (1)*.¹⁰ The subcommittee developed a suitable definition after all of the sources in the hierarchy were found wanting.

4. Terminology

¹⁰ The boldface numbers in parentheses refer to a list of references at the end of this standard.

3. Significance and Use

3.1 These terms have particular application to the forensic sciences. In addition, a hierarchy of sources of definitions were used in the development of this terminology. The hierarchy is

⁹ Information regarding Scientific Working Group on Imaging Technology/Scientific Working Group on Digital Evidence (SWGIT/SWGDE) is available from International Association for Identification (IAI), 2535 Pilot Knob Road, Suite 117, Mendota Heights, MN 55120-1120, <http://www.theiai.org>.

SECTION A: GENERAL (COMMON) FORENSIC SCIENCE TERMS

The terms defined in Section A are the direct responsibility of Subcommittee E30.92, Terminology.

accelerant, *n*—any material used to initiate or promote the spread of a fire. The most common accelerants are flammable or combustible liquids. Whether a substance is an accelerant depends not on its chemical structure but on its use.

IAAI Glossary

accuracy, *n*—the closeness of agreement between a test result and the accepted reference value. **E177**

DISCUSSION—(1) In practice, the accepted reference value is substituted for the true value.

(2) The term “accuracy,” when applied to a set of test or measurement results, involves a combination of random components and a common systematic error or bias component.

(3) Accuracy refers to a combination of trueness and precision.

ISO 3534:1993(E/F)

associative evidence, *n*—that evidence which tends to link a person, place, or thing with another person, place, or thing.

calibration, *n*—the set of operations that establishes, under specified conditions, the relationship between values indicated by a measuring instrument or measuring system or values represented by a material, and the corresponding known values of measurement.

DISCUSSION—This definition was originally defined in Terminology **E1187**, a standard discontinued by ASTM.

chain of custody, *n*—procedures and documents that account for the possession of a sample by tracking its handling and storage from its point of collection to its final disposition.

class, *n*—a group, set or kind marked by common attributes or a common attribute.

Webster's Unabridged Dictionary (2)

class characteristic(s), *n*—the attribute(s) that establish membership in a class.

classification, *n*—the systematic arrangement of persons or objects into categories (groups or classes) based on shared traits or characteristics.

Osterburg and Ward (3), p. 835

comparison sample, *n*—*fire debris*, (1) a sample of material collected from a fire scene which is, to the best of the collector's knowledge, similar with respect to relevant characteristics to a sample suspected of containing ignitable

substance, but which is not expected to contain an ignitable substance; (2) a sample of suspected ignitable substance submitted for the purpose of comparing with any ignitable substance separated from a debris sample.

DISCUSSION—A comparison sample should not be confused with a control sample. For example, a comparison sample might include unburned carpet or flooring that meets the requirements in (1).

control sample, *n*—material of established origin that is used to evaluate the performance of a test or comparison.

DISCUSSION—A control sample should not be confused with a comparison sample. For example, in fire debris, a control sample might include an empty can from the same lot as that used to collect samples.

criminalistics, *n*—a branch of forensic science concerned with the examination and interpretation of physical evidence, for the purpose of aiding forensic investigation.

exemplar, *n*—a specimen of physical evidence of known origin.

Osterburg and Ward (3), p. 837

expanded uncertainty (U), *n*—quantity defining an interval about a result of a measurement that may be expected to encompass a large fraction of the distribution of values that could reasonably be attributed to the measurand.

ISO GUM, EURACHEM

DISCUSSION—(1) The fraction may be regarded as the coverage probability or level of confidence of the interval.

(2) To associate a specific level of confidence with the interval defined by the expanded uncertainty requires explicit or implicit assumptions regarding the probability distribution characterized by the measurement result and its combined standard uncertainty. The level of confidence that may be attributed to this interval can be known only to the extent to which such assumptions can be justified.

(3) An expanded uncertainty *U* is calculated from a combined standard uncertainty *uc* and coverage factor *k* using:

$$U = k \times uc$$

false positive, *n*—a test result that states that a drug is present when, in fact, such a drug is not present in an amount greater than a threshold or designated cut-off concentration.

known, *adj*—of established origin associated with the matter under investigation.

limit of detection, *n*—the lowest content that can be measured with reasonable statistical certainty. **EURACHEM**

population, *n*—the totality of items or units of material under consideration.

DISCUSSION—The word “items” may be interpreted in the sense of measurements, or possible measurements, of a single characteristic, or occasionally for multiple characteristics, on all items or units of material being considered. The word “totality” may refer to items not available for inclusion in samples as well as those which are available.

E456

procedure, *n*—specified way to carry out an activity or a process.

DISCUSSION—(1) Procedures can be documented or not.

(2) When a procedure is documented, the term “written procedure” or “documented procedure” is frequently used. The document that contains a procedure can be called a “procedure document.”

ISO 9000:2005(E)

proficiency testing, *n*—*laboratory*, determination of laboratory testing performance by means of interlaboratory test comparisons.

E1301

qualitative analysis, *n*—*chemical*, analysis in which substances are identified or classified on the basis of their chemical or physical properties, such as chemical reactivity, solubility, molecular weight, melting point, radiative properties (emission, absorption), mass spectra, nuclear half-life, etc. (See also **quantitative analysis**.) **IUPAC Terminology**

quality assurance, *n*—all the planned and systematic activities implemented within the quality system, and demonstrated as needed, to provide adequate confidence that an entity will fulfill requirements for quality.

ISO Guide 2

quantitation limit, *n*—the minimum amount that can be quantitated with acceptable accuracy and precision.

E2161

quantitative analysis, *n*—*chemical*, analyses in which the amount or concentration of an analyte may be determined (estimated) and expressed as a numerical value in appropriate units. Qualitative analysis may take place without quantitative analysis, but quantitative analysis requires the identification (qualification) of the analytes for which numerical estimates are given.

IUPAC Terminology

questioned, *n*—associated with the matter under investigation about which there is some question, including, but not limited to, whether the questioned and known items have a common origin.

recovery, *n*—*chemical*, term used in analytical and preparative chemistry to denote the fraction of the total quantity of a substance recoverable following a chemical procedure.

IUPAC Terminology

reference material, *n*—a material or substance, one or more of whose property values are sufficiently homogenous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.

E1301

repeatability, *n*—precision under repeatability conditions.

E177, E456

repeatability conditions, *n*—conditions where independent test results are obtained with the same method on identical

test items in the same laboratory by the same operator using the same equipment within short intervals of time.

E177, E456

reproducibility, *n*—precision under reproducibility conditions.

E177, E456

reproducibility conditions, *n*—conditions where test results are obtained with the same method on identical test items in different laboratories with different operators using different equipment.

E177, E456

sample—subset of a population made up of one or more sampling units.

ISO 3534-1:2006

population—totality of items under consideration.

ISO 3534-1:2006

DISCUSSION—Note that a population may be real and finite, real and infinite, or completely hypothetical.

sampling unit—one of the individual parts into which a population is divided.

ISO 3534-1:2006

sampling, *n*—(the) process of drawing or constituting a sample.

E1402, ISO 3534:1993

selectivity, *n*—(1) (*qualitative*): the extent to which other substances interfere with the determination of a substance according to a given procedure; (2) (*quantitative*): a term used in conjunction with another substantive (for example, constant, coefficient, index, factor, number) for the quantitative characterization of interferences.

EURACHEM, IUPAC Terminology

standard, *n*—material of established origin with certified properties.

test, *n*—determination of one or more characteristics according to a procedure.

ISO 9000:2005(E)

test method, *n*—a definitive procedure that produces a test result.

E456

traceability—property of a result of a measurement or value of a standard whereby it can be related with a stated uncertainty, to stated references, usually national or international standards through an unbroken chain of comparisons.

ISO Guide 30:1992(E/F)

DISCUSSION—(1) The concept is often expressed by the adjective traceable.

(2) The unbroken chain of comparisons is called a traceability chain.

(3) (Applicable only to the French text.)

(4) Traceability of values in the certification of reference materials for chemical composition is discussed in ISO Guide 35:1989 (subclause 9.3.1) where attention is drawn to the special problems associated with chemical analysis. Traceability of the chemical species is frequently of equal or greater importance than the traceability of the calibration of the instruments used in the analysis.

validation, *n*—confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled.

DISCUSSION—(1) The term “validated” is used to designate the corresponding status.

(2) The use conditions for validation can be real or simulated.

ISO 9000:2005(E)

verification, *n*—confirmation, through the provision of objective evidence, that specified requirements have been fulfilled.

DISCUSSION—(1) The term “verified” is used to designate the corresponding status.

(2) Confirmation can comprise activities such as: performing alter-

native calculations; comparing a new design specification with a similar proven design specification; and undertaking tests and demonstrations, and reviewing documents prior to issue. **ISO 9000:2005(E)**

SECTION B: CRIMINALISTICS

The terms defined in Section B are the direct responsibility of Subcommittee E30.01, Criminalistics.

Section B1: Terms for Seized Drug Analysis

aggregation, *n*—the collecting of units or parts into a mass or whole. **E1968, E1969, E2125**

birefringence, *n*—property of some crystals, having more than one refractive index; this property will result in interference colors, which are viewed through a polarized light microscope. **E1968, E1969**

birefringence, *n*—property of some crystals having more than one refractive index; this will result in interference colors which are viewed through a polarized light microscope. **E2125**

blades, *n*—broad, flat, elongated crystals. **E1969**

capacity—the amount of finished product that could be produced, either in one batch or over a defined period of time, and given a set list of variables. **SWGDRUG, E2882**

catalyst—a substance whose presence initiates or changes the rate of a chemical reaction, but does not itself enter into the reaction. **D6161, E2882**

cocaine, *n*—either *d*- or *l*- cocaine; it should be noted that *l*-cocaine is the naturally occurring isomer found in the coca plant. **E1968**

dendritic, *adj*—multibrachiate or branching crystals, growing in a tree-like manner; each branch of the crystal is contiguous structurally. **E1968**

finished product—a manufactured product ready for use. **SWGDRUG, E2882**

grains, *n*—thick tablets having nearly equal width, breadth and thickness. **E1969, E2125**

habit, *n*—the external morphology of the crystal. **E1968, E1969, E2125**

intermediate—substance that is manufactured for and consumed in or used for chemical processing to be transformed into another substance. **F2725, E2882**

microdrop, *n*—a small drop of liquid that would fit on the end of a standard size, flattened toothpick; the approximate

volume of this drop would be 10 to 25 μL .

E1968, E1969, E2125

nails—a skeleton of some kinds of triangles, elongated, usually pointed with a short head usually thicker or broader. **E2125**

needles (acicular), *n*—long, thin crystals with pointed ends. **E1968, E1969, E2125**

nuggets—irregularly formed grains without sharp faces or edges. **E2125**

plates, *n*—blades with nearly equal length and breadth and of a thickness substantially less than the width. **E1969**

pliers—crystals resembling pliers, generally X-shaped. **E2125**

razor blades—thin oblong crystals with length about twice the width, resembling a safety razor blade. **E2125**

reagent—a chemical used to react with another chemical, often to confirm or deny the presence of the second chemical. **E1605, E2882**

rods, *n*—long, thin crystals with squared off ends. **E1969**

sheaves—elongated crystals form two opposite fans from the same joining point. **E2125**

skeletal crystal—a crystal in which all of the spaces in the crystal lattice are not occupied. **E2125**

spindles—shorter than coarse needles, but more substantial cross-section. **E2125**

tablets, *n*—plates with appreciable thickness but less than the length or breadth. **E1969**

yield, expected—the quantity of material or the percentage of theoretical yield anticipated at any appropriate phase of production based on previous laboratory, pilot scale, or manufacturing data. **E2363, E2882**

yield, theoretical—the quantity that would be produced at any appropriate phase of production based upon the quantity of material to be used, in the absence of any loss or error in actual production. **E2363, E2882**

Section B2: Terms for Gunshot Residue (GSR) Analysis and Smokeless Powder Analysis

- ball powders**, *n*—a class of smokeless powders produced by a process where the final grain morphologies are spherical, flattened-ball, or flake. **E2998**
- characteristic particles**, *n*—particles that have compositions rarely found in particles from any other source. **E1588**
- commonly associated particles**, *n*—particles have compositions that are also commonly found in environmental particles from numerous sources. However, when present, in addition to particles that are characteristic of, and/or consistent with GSR, these particles can be of significance in the interpretation of a population of particles and, consequently, the likelihood that that population is GSR. In isolation, however, such particles have little significance in examinations for GSR. **E1588**
- consistent particles**, *n*—particles that have compositions that are also found in particles from a number of relatively common, non-firearm sources. Particles within this group are produced through the operation of a variety of processes, equipment, or devices and can be found in the environment with varying levels of frequency. **E1588**
- deterrent**, *n*—a compound to slow the burning rate of a powder. **E2998**
- double-base**, *n*—propellant containing nitrocellulose and nitroglycerin. **E2998, E2999**
- energetic**, *n*—an explosive compound used to enhance the burning rate of a powder. **E2998**
- extruded powders**, *n*—a class of smokeless powders produced by an extrusion process where the final grain morphologies are disc or cylinder. **E2998**
- grain**, *n*—an individual particle of smokeless powder. **E2998, E2999**
- marker**, *n*—a colored grain of smokeless powder to assist in the visual identification of a bulk reloading smokeless powder. **E2998**
- morphology, n; morphological, adj**—referring to size, shape, structure, and texture. **E1588**
- perforation**, *n*—a hole in a disc powder or one or more holes running through the length of a cylinder powder created during the manufacturing process in extruded powders. **E2998**
- single-base**, *n*—propellant containing nitrocellulose as the major energetic material. **E2998, E2999**
- smokeless powder**, *n*—a propellant and low explosive composed of nitrocellulose and other organic and inorganic compounds. **E2998, E2999**
- stabilizer**, *n*—a compound to prevent or slow down self-decomposition. **E2998**
- stub**, *n*—sample device with an adhesive surface used to collect materials for SEM/EDS analysis. **E1588**
- triple-base**, *n*—propellant containing nitrocellulose, nitroglycerin, and nitroguanidine. **E2998, E2999**

Section B3: Terms for Paint Analysis

- absorbance**, *n*—logarithm to the base 10 of the reciprocal of spectral transmittance, (*T*). **E2808**
- $$A = \log_{10}(1/T) = -\log_{10}T$$
- DISCUSSION—It is often expressed as a fraction or decimal value and may be referred to as optical density.
- absorption**, *n*—transformation of incident energy into longer wavelength energy. **E2808**
- additive (modifier)**—any substance added in a small quantity to improve properties. Additives can include substances such as driers, corrosion inhibitors, catalysts, ultraviolet absorbers, plasticizers, etc. **E1610**
- additive (modifier)**, *n*—any substance added in a small quantity to improve properties; additives include substances such as driers, corrosion inhibitors, catalysts, ultraviolet absorbers, and plasticizers. **E2937**
- background**, *n*—the signal produced by the entire analytical system apart from the material of interest. **E2937**
- background X-rays (Bremsstrahlung, braking radiation, continuous spectrum)**, *n*—nonspecific X-ray radiation with a continuous energy range from zero up to the beam voltage in which background radiation results from the deceleration of beam electrons in the atomic Coulombic field. **E2809**
- DISCUSSION—A typical X-ray spectrum consists of both a continuous background and peaks from characteristic X-rays.
- backscattered electrons**, *n*—primary beam electrons that are scattered from the sample after undergoing few inelastic interactions. **E2809**
- DISCUSSION—The probability of backscattering is proportional to the atomic number.
- bandwidth**, *n*—optical width of the monochromator exit slit or the optical width of a semiconductor detector element that will vary with monochromator design. **E2808**
- DISCUSSION—This term can also refer to the wavelength interval over which radiant energy is greater than 50 % of the maximum intensity.
- binder**—a non-volatile portion of a paint which serves to bind or cement the pigment particles together. **E1610**

binder, *n*—a nonvolatile portion of the liquid vehicle of a coating, which serves to bond or cement the pigment particles together. **E2937**

bulk analysis, *n*—type of scanning electron microscopy (SEM) analysis that determines the average elemental composition of a material in which the area of analysis is as large as possible and may be achieved by a single large area raster or the summed results from multiple smaller area rasters. **E2809**

cathodoluminescence, *n*—emission of photons in the ultraviolet (UV), visible (Vis), and infrared (IR) regions of the electromagnetic spectrum as a result of electron beam interaction with certain materials. **E2809**

characteristic X-rays, *n*—X-ray emission resulting from de-excitation of an atom following inner shell ionization in which the energy of the X-rays is related to the atomic number of the atom, providing the basis for energy dispersive X-ray spectrometry (EDS). **E2809**

DISCUSSION—A typical X-ray spectrum consists of both a continuous background and peaks from characteristic X-rays.

charge-coupled device (CCD), *n*—a silicon-based semiconductor chip consisting of a two-dimensional matrix of photo sensors or pixels. **E2808**

charging, *n*—negative charge accumulation on either a non-conductive sample or a sample that is not properly grounded. **E2809**

DISCUSSION—This effect may interfere with image formation and X-ray analysis because of beam deflection. It can usually be eliminated by the application of a conductive coating.

chromaticity, *n*—dimensions of a color stimulus, excluding luminous intensity, and expressed in terms of hue and saturation (Commission Internationale de l’Eclairage (CIE)) or redness-greenness and yellowness-blueness (L^* , a^* , b^*). **E2808**

DISCUSSION—It is generally represented as a point in a constant luminance plane of a three-dimensional color space.

chromaticity coordinates, CIE, *n*—ratios of each of the three tristimulus values X , Y , and Z in relation to the sum of the three designated as x , y , and z , respectively. **E2808**

DISCUSSION—They are sometimes referred to as the trichromatic coefficients. When written without subscripts, they are assumed to have been calculated for Illuminant C and the 2° (1931) Standard Observer unless specified otherwise. If they have been obtained for other illuminants or observers, a subscript describing the observer or illuminant should be used. For example, x_{10D} and y_{10D} are chromaticity coordinates for the 10° observer and Illuminant D. A “standard observer” refers to specific numerical values that represent the nominal color response of the human eye to different wavelengths of light. It is based on a study of the average retinal response of the human population.

chromaticity diagram, CIE, *n*—two-dimensional graph that describes a color as the locus of chromaticity coordinates in a field of monochromatic light varying from 380 to 780 nm in wavelength where X is the abscissa of the coordinate system and Y is the ordinate and it is used to describe and compare the colors of both luminous and non-luminous materials. **E2808**

CIELAB Unit E, *n*—($L^*a^*b^*$) color difference equation from Practice E1402. **E2808**

DISCUSSION—The color difference E between two samples is given by:

$$\Delta E_{CIE}(L^*, a^*, b^*) = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

where:

L^* (pronounced “L star”) = where a color falls on a vertical scale from light to dark,
 a^* = where the color falls on the continuum of colors between red and green, and
 b^* = where the color falls on the continuum of colors between blue and yellow.

coating—a generic term for paint, lacquer, enamel, or other liquid or liquifiable material which is converted to a solid, protective, decorative, or combination thereof, film after application. **E1610**

coating, *n*—a generic term for paint, lacquer, enamel, or other liquid or liquefiable material that is converted to a solid, protective, or decorative film or a combination of these types of films after application. **E2937**

colorimetry, *n*—conversion of instrumental light measurements into psychophysical descriptions or numerical notations that can be correlated with visual evaluations of color and color differences. **E2808**

concentration, *n*—for the purpose of this guide, the following ranges shall apply: major: greater than 10 %; minor: 1 to 10 %; and trace: less than 1 % . **E2809**

dead time, *n*—time during which the EDS is not able to process X-rays. **E2809**

DISCUSSION—Dead time is typically expressed as a percentage of real time during which the detector is not collecting X-ray data.

detector fluorescence peak (dead-layer peak, silicon internal fluorescence peak), *n*—peak resulting from the emission of characteristic X-rays in a thin layer of inactive crystal area in the front of an EDS detector. **E2809**

DISCUSSION—The peak is characteristic of the type of detector, such as silicon for a lithium-drifted silicon detector. In a silicon detector, this peak may appear at 0.2 % apparent concentration.

discriminate—to distinguish between two samples based on meaningful differences; to differentiate. **E1610**

discriminating power—the ability of an analytical procedure to distinguish between two items of different origin. **E1610**

effect pigment, *n*—any paint pigment that is designed to produce a significant change in color attribute(s) in a paint film when the film is viewed or illuminated from varied geometries. **E2808**

electron probe microanalyzer (EPA, EPMA, EMMA), *n*—electron beam instrument designed for quantitative X-ray analysis (electron probe microanalysis). **E2809**

DISCUSSION—It is related to SEM but with multiple wavelength spectrometers and is designed to work at reproducible and stable beam currents and specimen-beam-X-ray detector geometries. Electron probe

microanalysis is the determination of elemental concentration by X-ray emission from the microvolume of material in which a static electron beam interacts.

embedding, *n*—procedure for casting a sample in a block of material that polymerizes, or otherwise hardens, to permit handling during further preparation. **E2809**

energy dispersive X-ray spectrometry (EDS, EDXA, EDX), *n*—EDX spectrometry is complementary to wavelength dispersive spectrometry (WDS). **E2809**

error ellipse (visual limits), *n*—plotted limits of variation in visually indistinguishable color coordinate values that form an elliptical shape around a central color value when plotted in a chromaticity diagram. **E2808**

escape peak, *n*—peak resulting from incomplete deposition of the energy of an X-ray entering the EDS detector. **E2809**

DISCUSSION—This peak is produced when an incoming X-ray excites a silicon atom within the detector crystal and the resulting silicon (Si) K-alpha fluorescence X-ray exits the detector crystal. It occurs at the principal peak energy minus the energy of the Si K-alpha fluorescence X-ray (1.74 KeV). The escape peak intensity is about 1 to 2 % of the parent peak.

extraneous material, *n*—material originating from a source other than the specimen (synonyms: contaminant and foreign material). **E2809**

extraneous material (contaminant, foreign material), *n*—material originating from a source other than the specimen. **E2937**

final aperture, *n*—last beam-restricting orifice in an electron optical column. **E2809**

DISCUSSION—The orifice diameter influences the beam current and depth of focus.

grating, *n*—parallel set of linear, regularly repeating structures that, when illuminated, produces maxima and minima of light intensity as a consequence of interference. **E2808**

DISCUSSION—These maxima and minima vary in position with wavelength. This allows radiation of any given wavelength to be isolated from a complex mixture of wavelengths and allows the grating to be used as a monochromator.

illumination aperture, *n*—element in the optical path of a microspectrophotometric (MSP) system that limits the area of illumination reaching the sample focal plane. **E2808**

interaction volume, *n*—sample volume in which the electron beam loses most of its energy. **E2809**

DISCUSSION—It is generally thought of as the volume in which detectable X-rays are produced. The actual volume varies depending upon beam voltage, average atomic number, and density of the sample.

known sample—a coating sample of established origin. **E1610**

live time, *n*—time in which the EDS electronics are available to accept and process incoming X-rays. **E2809**

DISCUSSION—Live time is often expressed as a percentage of real time.

meaningful difference—a feature or property of a sample that does not fall within the variation exhibited by the compar-

ison sample, considering the limitations of the sample or technique, and therefore indicates the two samples do not share a common origin. The use of this term does not imply the formal application of statistics. **E1610**

meaningful difference(s), *n*—a feature or property of a sample that does not fall within the variation exhibited by the comparison sample, considering the limitations of the sample or technique, and therefore indicates the two samples do not share a common origin. The use of this term does not imply the formal application of statistics. **E2937**

measuring aperture, *n*—element in the optical path of a microspectrophotometric (MSP) system that limits the area of illumination reaching the detector focal plane. **E2808**

microtomy, *n*—sample preparation method that sequentially passes a blade at a shallow depth through a sample resulting in sections of selected thickness as well as a flat block. **E2809**

DISCUSSION—Each may be used for the determination of sample characteristics.

microtomy, *n*—a sample preparation method that sequentially passes a blade at a shallow depth through a specimen, resulting in sections of selected thickness. **E2937**

monochromator, *n*—device designed to isolate narrow wavelength ranges of light from complex, broad-spectrum radiation. **E2808**

paint, *n*—a pigmented coating. **E2937**

paint—commonly known as a pigmented coating (see coating). **E1610**

particle analysis, *n*—analytical method intended to determine the elemental composition of a single particle such as a pigment particle in a paint layer. **E2809**

DISCUSSION—Usually performed with a static (nonscanning) electron beam.

photomultiplier tube (PMT), *n*—photosensitive vacuum tube device that quantitatively converts photons of light into electrical energy. **E2808**

pigment, *n*—a finely ground, inorganic or organic, insoluble, and dispersed particle; besides color, pigments provide many of the essential properties of paint such as opacity, hardness, durability, and corrosion resistance; the term pigment includes extenders. **E2937**

pigment—a finely ground, inorganic or organic, insoluble, dispersed particle. Besides color, a pigment can provide many of the essential properties of paint, such as opacity, hardness, durability, and corrosion resistance. The term pigment includes extenders. **E1610**

pulse processor time constant, *n*—operator-selected value for pulse-processing time in which a higher value (longer time) results in a more accurate determination of the detector amplifier pulse height (better spectral resolution) and a lower value results in a higher count rate but with reduced spectral resolution. **E2809**

questioned sample—a coating sample whose original source is unknown. **E1610**

raster, n—rectangular pattern scanned by the electron beam on a sample. **E2809**

DISCUSSION—The raster dimensions change inversely with magnification.

reflectance, R, n—the ratio of the radiant power reflected by the specimen to the radiant power incident on the specimen. **E2808**

DISCUSSION—In popular usage, it is considered as the ratio of the intensity of reflected radiant energy from a test sample to that reflected from a defined reference standard.

representative sample, n—representative portion of the specimen selected and prepared for analysis that is believed to exhibit all of the elemental characteristics of the parent specimen. **E2809**

sample polishing, n—sample preparation method using progressively finer abrasives to achieve a flat, smooth sample surface. **E2809**

DISCUSSION—Generally, this is required for quantitative analysis.

sample size, n—for the purposes of this guide, the following terms are used to describe sample size with the actual size demarcation between each being somewhat arbitrary. **E2809**

fragment, n—only within this guide, sample or specimen smaller than approximately 0.2 mm. **E2809**

DISCUSSION—If the material from which the fragment originated was layered, then the fragment may also show a layered structure with light microscopy inspection and SEM analysis. A fragment is frequently not of sufficient size to permit multiple tests.

particle, n—only within this guide, sample or specimen whose greatest dimension is less than approximately 50 μm . **E2809**

DISCUSSION—Material of this size generally has none of the overall structural characteristics that can be associated with the material from which the particle originated. A particle is generally not of sufficient size to permit multiple tests.

piece, n—sample or specimen larger than approximately 0.2 mm. **E2809**

DISCUSSION—If the material from which the piece originated was layered, then the piece may show a layered structure. A sample of this size is sufficient to perform all of the suggested cross-sectional preparation and analytical methods.

scanning electron microscopy (SEM), n—type of electron microscope in which a focused electron beam is scanned in a raster on a solid sample surface. **E2809**

DISCUSSION—The strength of resulting emissions of signals varies according to sample characteristics such as composition or topography. As the electron beam of the SEM scans the surface of a sample, a signal is continuously registered by the imaging system which produces a two-dimensional image of the sample on the display monitor. By popular usage, the term SEM may also include the analytical techniques EDS and WDS.

secondary electrons (SE), n—low-energy electrons produced from the interaction of beam electrons and conduction band electrons of atoms within the interaction volume that are produced throughout the interaction volume, but only those near the surface have enough energy to escape. **E2809**

DISCUSSION—The secondary electron signal is typically used to form topographic images.

significant difference, n—difference between two specimens that indicates their possible common origin cannot be established. **E2808**

smear, n—transfer of paint resulting from contact between two objects and consisting of comingled particles, fragments, and possible pieces of one or both surfaces. **E2809**

smear, n—a transfer of paint resulting from contact between two objects; these transfers can consist of co-mingled particles from two or more sources, fragments, or contributions from a single source. **E2937**

specimen, n—material submitted for examination. **E2809**

DISCUSSION—Samples are removed from a specimen for analysis.

spectral artifacts, n—spectral peaks other than characteristic peaks produced during the EDS detection process. **E2809**

DISCUSSION—Examples are escape peaks and sum peaks.

spectral resolution, n—measure of the ability to distinguish between adjacent peaks in an X-ray spectrum and it is usually determined by measuring peak width at half the maximum value of the peak height or full-width half-maximum. **E2809**

standard illuminant, CIE, n—standard sources for which the CIE specified the spectral energy distribution as follows: **E2808**

standard illuminant A, CIE, n—tungsten filament lamp operated at a color temperature of 2856 K, approximating a blackbody operating at that temperature. **E2808**

DISCUSSION—It is defined in the wavelength range of 380 to 770 nm.

standard illuminant C, CIE, n—approximation of overcast daylight having a correlated color temperature of approximately 6770 K. **E2808**

DISCUSSION—This color of light can be obtained by using a combination of Illuminant A and a color-correcting filter. It is defined in the wavelength range of 380 to 770 nm.

standard illuminant D, CIE, n—approximation of bright daylight illumination having a correlated color temperature of 6504 K in the spectral range of 300 to 830 nm. **E2808**

DISCUSSION—The UV portion of Illuminant D, 300 to 380 nm, is necessary to describe correctly colors that contain fluorescent colorants or ultraviolet (UV) absorbers. The UV and visible portions are designated as UVD and VisD. Illuminant D is based on actual measurements of the spectral distribution of daylight and is the most commonly used standard illuminant for spectral measurements.

standard observer, CIE, n—visual color perception data set adopted by CIE to represent the response of the average human eye when light adapted to an equal energy spectrum. **E2808**

DISCUSSION—Unless otherwise specified, the term applies to the data adopted in 1931 for a 2° field of vision. The data adopted in 1964, sometimes called the 1964 observer, were obtained for a 10° field of vision and are generally used in industrial measurements.

step width, n—distance between two points of wavelength measurement in a spectrum, not to be confused with resolution although it can have an impact on resolution. **E2808**

sum peak, *n*—peak occurring at the sum of the energy of two individual peaks. **E2809**

system peaks (stray radiation), *n*—peaks that may occur in the X-ray spectrum resulting from interaction of the electron beam or fluorescent radiation with components of the SEM itself. **E2809**

takeoff angle, *n*—angle between the specimen surface and the detector axis. **E2809**

thermochromy, *n*—characteristic of some materials, including some pigments, to change color as temperature changes. **E2808**

thick section, *n*—for the purpose of this guide, a sample that is 2 μm or thicker. **E2809**

thin section, *n*—for the purpose of this guide, a sample with a thickness of less than 2 μm. **E2809**

transmission electron microscopy (TEM), *n*—type of electron microscopy in which an image of a sample prepared as a thin section is formed by the interaction of the beam passing through the sample. **E2809**

transmittance, T, *n*—the ratio of radiant power transmitted by the specimen to the radiant power incident on the specimen. **E2808**

DISCUSSION—Both absorption and reflection influence total transmittance.

tristimulus values, CIE, *n*—amounts (in percent) of the three components necessary in a three-color additive mixture required for matching a color. **E2808**

DISCUSSION—These components are designated as X, Y, and Z in the CIE system. The illuminant and standard observer color-matching functions must be designated. If they are not, an assumption is made that the reported values are for the 1931 observer (2° field) and Illuminant C. The values obtained depend on the method of integration used, the nature of the sample surface, sample homogeneity, and the instrument design. Tristimulus values are therefore not absolute values for a sample, but relative values dependent on the method used to obtain them. Examples of calculations of tristimulus values in the CIE system can be found in Practice E308.

variable pressure scanning electron microscopy (LV, CP, VP, ESEM), *n*—type of SEM that is designed to operate at higher chamber pressure than the conventional in which the need for application of a conductive coating is minimized when using a variable pressure SEM; however, EDS may be complicated because of the electron beam spread experienced at higher operating pressures. **E2809**

wavelength dispersive spectroscopy (WDS, WDXA), *n*—X-ray spectroscopy that separates and identifies X-rays based on their differences in wavelength. **E2809**

DISCUSSION—WDS is a complementary spectroscopy to EDS.

Wood's anomaly, *n*—effect caused by a polarization of diffracted energy as a result of non-uniform reflection as the angle of incidence varies on a holographically blazed monochromator. **E2808**

DISCUSSION—This effect can be observed as a distinct transmittance maximum within the spectrum.

Section B4: Terms for Textile, Fiber, Cord, and Tape Examination

activation—the heating of the adsorbent layer on a plate to dry out the moisture and maximize its adsorptive power. **E2227**

adsorbent—the stationary phase for adsorption TLC. **E2227**

adsorption—the attraction between the surface atoms of a solid and an external molecule by intermolecular forces. **E2227**

anisotropic, *adj*—a characteristic of an object in which the refractive index differs depending on the direction of propagation or vibration of light through the object. **E2228, McCrone (4)**

aperture, *n*—an opening in an optical system that controls the amount of light passing through a system. **E2224**

attenuated total reflection (ATR), *n*—a method of spectrophotometric analysis based on the reflection of energy at the interface of two media which have different refractive indices and are in intimate contact with each other. **E2224**

background, *n*—apparent absorption caused by anything other than the substance for which the analysis is being made. **E2224, E131**

background, *n*—the signal produced by the entire analytical system apart from the material of interest. **E3085**

barrier filter, *n*—a filter used in fluorescence microscopy that suppresses unnecessary excitation energy that has not been absorbed by the fiber and selectively transmits only energy of greater wavelengths than the cut-off wavelength or within a specific wavelength range. **E2228**

Becke line, *n*—the bright halo near the boundary of a fiber that moves with respect to that boundary as the microscope is focused through best focus when the fiber is mounted in a medium that differs from its refractive index. **E2228, McCrone (4)**

Becke line method, *n*—a method for determining the refractive index of a fiber relative to its mountant by noting the direction in which the Becke line moves when the focus is changed. **E2228, McCrone (4)**

DISCUSSION—The Becke line always moves toward the higher refractive index medium (fiber or mountant) when focus is raised (stage is lowered) and towards the lower refractive index medium when focus is lowered (stage is raised). At the point where the index of the fiber matches the index of the mounting medium, the Becke line is no longer visible. The Becke line is generally viewed at a wavelength of 589 nm (the D line of Sodium [n_D]).

birefringence, *n*—the numerical difference in refractive indices (n) for a fiber, given by the equation:

$$|n_{\parallel} - n_{\perp}|$$

Birefringence (B) can be calculated by determining the retardation (r) and thickness (T) at a particular point in a fiber and by using the equation:

$$B = r \text{ (nm)} / 1000T \text{ (}\mu\text{m)}$$

E2228, McCrone (4)

braid, n —the intertwining of strands in a braiding process to produce a rope structure.

E2225, The Cordage Institute (5)

cellulosic fiber, n —fiber composed of polymers formed from glucose subunits.

E2224

chamber—a glass chamber in which TLC development is carried out.

E2227

chromatography—a method of analysis in which substances are separated by their differential migration in a mobile phase flowing through or past a stationary phase.

E2227

comparison microscope, n —a system of two microscopes positioned side-by-side and connected via an optical bridge so that two specimens are examined simultaneously in either transmitted or reflected light.

E2228

compensator, n —any variety of optical devices that can be placed in the light path of a polarized light microscope to introduce known, fixed or variable retardation in a specific vibration direction; the retardation and sign of elongation of the fiber may then be determined.

E2228, Delly (6)

DISCUSSION—Compensators may employ a fixed mineral plate of constant or varying thickness or a mineral plate that is rotated, or have its thickness varied by tilting, to alter the thickness presented to the optical path (and retardation introduced) by a set amount.

compensator, full-wave (or red plate), n —a compensator (usually a plate of gypsum, selenite or quartz) that introduces a fixed retardation between 530 to 550 nm (approximately the retardation of the first order red color on the Michel-Lévy chart).

E2228, McCrone (4), Delly (6)

compensator, quarter-wave, n —a compensator (usually a mica plate) that introduces a fixed retardation between ~137–147 nm (approximately the retardation of first-order gray on the Michel-Lévy chart).

E2228, McCrone (4), Delly (6)

compensator, quartz wedge, n —a wedge, usually cut from quartz, having continuously variable retardation extending over several orders (usually 3 to 7) of interference colors.

E2228, McCrone (4)

compensator, Sénarmont, n —a quarter-wave plate inserted above the specimen in the parallel “0” position with a calibrated rotating analyzer; measures low retardation and requires the use of monochromatic light.

E2228

compensator, tilting (Berek), n —a compensator typically containing a plate of calcite or quartz, which can be tilted by

means of a calibrated drum to introduce variable retardation.

E2228

cord, n —a twisted or formed structure composed of one or more single or plied filaments, strands, or yarns of organic polymer or inorganic materials.

E2225, D123

DISCUSSION—Generally, cords have a diameter less than $\frac{3}{16}$ in.

cordage, n —a collective term for twines, cords and ropes made from textile fibers and yarns.

E2225, The Cordage Institute (5)

core, n —a textile product (yarn, strand, small diameter rope, etc.) placed in the center of a rope and serving as a support for the strands around it.

E2225, The Cordage Institute (5)

DISCUSSION—Core can be of any continuous construction including parallel strands, twisted strands or braided strands.

cortex, n —the main structural component of hair consisting of elongated and fusiform (spindle-shaped) cells; the cortex may contain pigment grains, air spaces called cortical fusi, and structures called ovoid bodies.

E2228

course, n —*in knitted fabrics*, a row of successive loops in the width direction of the fabric.

E2225, D123

crimp, n —the curl, wave, or compression that is naturally occurring or otherwise imparted to a fiber.

E2228

crown, n —the raised portion of a strand in twisted cordage.

E2225

cuticle, n —*in mammalian hair fibers*, the layers of flattened cells enclosing the cortex, which form an envelope of overlapping scales surrounding the fiber.

E2228

delustrant, n —a pigment, usually titanium dioxide, used to dull the luster of a manufactured fiber.

E2224, E2228, KoSa (7)

development—the movement of the mobile phase through the adsorbent layer to form a chromatogram.

E2227

dichroism, n —the property of exhibiting different colors, especially two different colors, when viewed along different axes by plane polarized light.

E2228

dislocations, n —distinct features that occur in natural fibers (for example, flax, ramie, jute, hemp) in the shape of X’s, I’s, and V’s that are present along the fiber cell wall; these features are often useful for identification.

E2228

dispersion of birefringence, n —the variation of birefringence with wavelength of light.

E2228

DISCUSSION—When dispersion of birefringence is significant in a particular fiber, anomalous interference colors not appearing in the regular color sequence of the Michel-Lévy chart may result. Strong dispersion of birefringence may also interfere with the accurate determination of retardation in highly birefringent fibers.

dispersion staining, n —an optical staining technique in which colors are produced by the differential refraction of different wavelengths of light due to mounting the sample in a liquid having a different dispersion of refractive index.

E2228, McCrone (4)