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Standard Terminology Relating to Trace Materials Analysis

Trace Materials Subcommittee
Chemistry: Trace Evidence Scientific Area Committee (SAC)
Organization of Scientific Area Committees (OSAC) for Forensic Science

OSAC Proposed Standard

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Standard Terminology Relating to Trace Materials Analysis

1. Scope

1.1 This terminology standard is a compilation of terms and corresponding definitions related to the analysis of Trace Materials, including but not limited to fibers, glass, hair, paint, tape, and geological materials. Legal or scientific terms that are generally understood or defined adequately in other readily available sources may not be included.

1.2 The values stated in SI units are to be regarded as the standard. No other units of measurement are included in this standard.

1.3 *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*:

D123 Terminology Relating to Textiles
E1732 Terminology Relating to Forensic Science
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 Dyes in Textile Fibers by Thin-Layer Chromatography
E2228 Guide for Microscopical Examination of Textile Fibers
E3406 Guide for Microspectrophotometry in Forensic Fiber Analysis
WK78747 Guide for the Forensic Examination of Fibers
WK 78748 Practice for a Forensic Fiber Training Program

3. Significance and Use

3.1 These terms have particular application to the analysis of trace materials, including but not limited to fibers, glass, hair, paint, tape, and geological materials. This standard is intended to aid the user in the understanding of, and serves to bring consistency to, the use of terminology across ASTM standards on trace materials.

4. Terminology

4.1 *Definitions:*

aggregate(s) [clump(s)], *n*—a group of soil particles that cohere to each other more strongly than to other surrounding particles (**12**).

DISCUSSION— (1) Soil aggregates can be natural (a ped) or formed by human activities (a clod). Often the genesis of evidentiary soil aggregates is unknown, so aggregate is often a preferred term in descriptions of soil evidence. (2) This use of the term aggregate is

distinct from this term's use in construction as the sand or crushed rock mixed with cement to form mortar, grout, or concrete.

alibi location(s), *n*—a known location suggested or linked to a subject (for example, a subject's home) that is distinct from the crime scene.
DISCUSSION—The term alibi or alibi location can be perceived negatively, but comparisons of geological materials from alibi locations can be exonerating. Alibi location is used to be succinct, however use of this term in documentation of evidence, evidence examination reports, or courtroom testimony is discouraged.

anagen, *n*—the active growth phase of a hair follicle in the hair growth cycle (**4**).
DISCUSSION - the root from a pulled anagen hair is elongated and is usually fully pigmented.

ancestral group, *n*—a biogeographic designation of human populations (for example, Asian, African, European) whose hair can share similar morphological and microscopic traits (**5**).
DISCUSSION—The racial terms Caucasoid, Mongoloid, and Negroid should not be used as these terms are no longer acceptable in the field of anthropology (the field from which these designations originated)

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 (**8**).

arrest lines, *n*—a sharp line on the fracture surface defining the crack front shape of an arrested or momentarily-hesitated crack (**10**).

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.

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

background radiation, *n*—X-rays resulting from scattered Bremsstrahlung and coherently and incoherently scattered tube target peaks.

backing, *n*—a thin flexible material to which adhesive is applied.

backscattered electron (BE) imaging, *n*—a technique that uses high energy electrons that originate from the primary electron beam of the SEM and are elastically reflected by the specimen to create an image of the sample. The probability of backscattering is proportional to atomic number.

backsize, *n*—a layer applied to the top side of the backing. Its purpose is to coat and fill a porous surfaced backing with a material that is inert to the adhesive formulation to be used.

biaxially oriented polypropylene (BOPP), *n*—an oriented polypropylene film in which the polymer has been stretched in both the machine direction and cross direction during the manufacturing process. Tapes with such films cannot be torn by hand.

binder, *n*—a non-volatile portion of a paint which serves to bind or cement the pigment particles together.

Bragg equation or Bragg's law, *n*—describes the physical phenomenon of X-ray scattering from a crystallographic three-dimensional lattice plane as $n\lambda=2d\sin\theta$, in which n is any integer, λ is the wavelength of the X-ray, d is the crystal plane separation, also known as d-spacing, and θ is the angle between the crystal plane and the diffracted beam, also known as the Bragg Angle.

braid, *n*—a rope or textile structure formed by the intertwining of strands.

buckling, *n*—an abrupt change in the shape and orientation of a hair shaft with or without a slight twist.

calendering, *v*—a method of producing adhesive tape by pressing an adhesive to a backing material through a series of heated rollers. The surface appearance depends on the type of roller used.

calendering marks, *n*—characteristic marks left on the backing material due to the manufacturing process.

cantilever curl (compression curl), *n*—a curved lip formed on the compression side under (perpendicular to) a bending stress.

> DISCUSSION—When a crack is generated by a bending stress, it initially propagates perpendicular to the surface which is in tension and upon which the fracture originated. As the crack propagates toward the surface that was originally in compression, the plane of tension rotates, causing a rotation in the developing crack surface. By the time the crack intersects the opposite surface a ridge, or lip, has formed. [**C1256**]

catagen, *n*—the transitional phase of the hair follicle between the active growth phase (anagen) and the resting phase (telogen) in the hair growth cycle.

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.

cellophane, *n*—a thin, transparent sheet made of regenerated cellulose that can be used as a backing material in tape products.

cellulose acetate, *n*—a type of transparent film that is used for tape backings.

DISCUSSION—A matte surface is used for write-on tapes. Cellulose acetate is more moisture-resistant than cellophane.

cellulosic fiber, *n*—fiber composed of polymers formed from glucose subunits (for example, vegetable, rayon/ Lyocell).

characteristic X-ray, *n*—X-ray emission resulting from de-excitation of an atom following inner shell ionization.

DISCUSSION—The energy of a characteristic X-ray is related to the atomic number of the atom, providing the basis for energy dispersive X-ray spectroscopy.

charge-coupled device (CCD), *n*—a silicon-based semiconductor chip consisting of a linear or two-dimensional array of photo sensors or pixels that transfers an electrical charge and converts it into a digital value.

charging, *n*—negative charge accumulation on either a nonconductive sample or a sample that is not properly grounded.

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

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

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.

concentric fractures, *n*—fractures forming in an approximately circular pattern around the point of impact. They are usually in straight segments that terminate at an existing radial crack (**6**).

conchoidal fracture, *n*—a type of fracture that produces smooth, curved, and usually striated surfaces.

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.
DISCUSSION—Generally, cords have a diameter less than 3⁄16 in.

cordage, *n*—a collective term for twines, cords and ropes made from textile fibers and yarns (**1**).

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 (**1**).

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 located between the cuticle and the medulla.

cortical fusi, *n*—small air spaces that form between the cortical cells in the hair shaft and, under transmitted light, appear as tiny, dark structures.

cortical texture, *n*—the relief or definition of the margins of the cortical cells when viewed using transmitted light microscopy.

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

creped paper, *n*—paper that has small folds in it giving it high stretch and conformability. Used in the backing of masking tape (saturated paper tape).

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

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

crystal, *n*—homogeneous, solid body of a chemical element or compound, having a regularly repeating atomic arrangement that can be outwardly expressed by plane faces (adapted from 9).

crystal lattice, *n*—the three-dimensional regularly repeating set of points that represent the translational periodicity of a crystal structure.

DISCUSSION—Each lattice point has identical surroundings. Lattice is the abstract pattern used to describe the internal geometric structure of crystals. Lattice and structure are not synonymous, as structure refers to the real mineral material (adapted from 9).

crystalline, *adj*—having a crystal structure or a regular arrangement of atoms in a crystal lattice.

curie point, *n*—the temperature at which a ferromagnetic metal loses its ferromagnetic properties.

cuticle, *n*—the outermost region of a hair composed of layers of overlapping scales.

DISCUSSION—The dimension of the cuticle as measured from its outer margin to the cortex is often described in relative terms (for example, thin, medium, thick).

cuticle, cracked, *n*—a cuticle with linear breaks that are perpendicular to the length of the shaft.

cuticle, looped, *n*—a cuticle in which the distal edges of the cuticular scales are curved away from or cupped toward the hair shaft.

cuticle, serrated, *n*—a cuticle in which the outer margin has a notched appearance like a saw blade.

d-spacing, *n*—in diffraction of X-rays by a crystal, the distance or separation between successive and identical parallel planes in the crystal lattice; d-spacing is expressed as d in the Bragg equation (adapted from **9**).

dead time, *n*—the time (expressed as a percentage of real time) during which the energy dispersive X-ray spectrometer is not able to process X-rays.

decompositional changes, *n*—alteration in the root or the proximal end of a hair that can include discoloration, postmortem root banding, or a tapered or brush-like appearance as well as fungal tunneling along the length of the shaft.

delustrant, *n*—a pigment, usually titanium dioxide, used to dull the luster of a manufactured fiber (**7**).

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

diffractometer, *n*—an instrument that records either powder or single-crystal X-ray diffraction patterns.

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

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.

dispersion, *n*—the difference in refractive index of a given material for different wavelengths of the spectrum.

dye, *n*—soluble substances that add color to textiles (**7**).

DISCUSSION—Dyes are classified into groups that have similar chemical characteristics (for example, aniline, acid, and azo). They are incorporated into the fiber by chemical reaction, absorption, or dispersion.

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 angles.

elastomer, *n*—a material that can be deformed but when the forces are removed it returns to its original form. Serves as the base material for pressure sensitive adhesives.

energy dispersive X-ray spectroscopy (EDS, EDXA, EDX), *n*—X-ray spectroscopy based on the simultaneous measurement of the energies of X-rays emitted by a sample.

escape peak, *n*—a spectral artifact resulting from incomplete deposition of the energy of an X-ray entering the energy dispersive X-ray spectrometer detector.

DISCUSSION—An escape peak is produced when an incoming X-ray excites a silicon atom within the detector crystal, and the resulting Si Kα fluorescence X-ray exits the detector crystal. It occurs at the energy for the original X-ray minus the energy of the Si Kα fluorescence X-ray (1.74 keV). The escape peak intensity is about 1-2 % of the parent peak.

excitation filter, *n*—a filter used in fluorescence microscopy that transmits specific bands or wavelengths of energy capable of inducing visible fluorescence in various substrates.

extinction, *n*—the condition in which a birefringent particle appears dark when viewed between crossed polarizers (**2**).

DISCUSSION—Most fibers exhibit extinction when their long axis is oriented parallel to the privileged direction of one of the polarizing filters.

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

filament, *n*—in textiles, a continuous fiber of extremely long length.

flatback paper, *n*—smooth paper backing masking tape (saturated paper tape).

float glass, *n*—sheet glass made by floating molten glass on a bed of molten tin.

fluorescence microscope, *n*—a microscope equipped with a high energy light source (usually a xenon or mercury vapor lamp) and a set of excitation and barrier filters, used to induce and observe fluorescence in fibers and other particles or materials.

folicular tag, *n*—tissue from a hair follicle that is still attached to the root end of a hair which has been forcibly removed.

fractography, *n*—the means and methods for characterizing fractured specimens or compounds (**10**).

fracture mirror, *n*—a smooth portion of the fracture surface surrounding the origin, the single unique location at which every fracture system begins to form.

frosting, *n*—a finely grained, slightly roughened surface texture.

fungal tunneling, *n*—air pockets in a hair shaft caused by fungal growth.

generic class, *n*—as used with textile fibers, a grouping having similar chemical compositions or specific chemical characteristics.

DISCUSSION—A generic name applies to all members of a group and is not protected by trademark registration. Generic names for manufactured fibers include, for example, rayon, nylon, and polyester. Generic names used in the United States for manufactured fibers were established as part of the Textile Fiber Products Identification Act enacted by Congress in 1954 (**13**).

glass, *n*—an inorganic product of fusion that has been cooled to a rigid condition without crystallization.

grating, *n*—parallel set of linear, regularly repeating grooves that, when illuminated, produces dispersion of light into its requisite wavelengths with maxima and minima of light intensity as a consequence of interference.

DISCUSSION—These maxima and minima vary in position with wavelength. This allows radiation of any given wavelength to be isolated from a mixture of wavelengths (for example, white light) and allows the grating to be used as part of a monochromator. The dispersion or ability to resolve separate wavelengths is expressed as the number of lines (or steps) in the grating per millimeter.

hackle marks, *n*—lines parallel to the direction of crack propagation separating portions of the crack surface that are parallel but not coplanar.

hair, *n*—a slender outgrowth from the skin of mammals.

hair follicle, *n*—an invagination of the epidermis which contains the root of the hair.

Hartmann net, *n*—a graph of refractive index versus wavelength that uses a series of parallel lines to represent the relationship between wavelength versus refractive index at a fixed temperature for an immersion oil.

Hertzian cone (percussion cone), *n*—a funnel-shaped area of damage caused by a high-velocity impact from a small, hard body against the center (**3**).

imbricate, *n*—a term that describes a scale pattern in which the scales overlap and the edges have an irregular wavy pattern; this pattern is typical of human hair.

incoherent (Compton) scatter peaks, *n*—spectral artifacts that result from inelastic scattering of the tube target characteristic X-rays by the sample.

DISCUSSION—Because energy is lost in inelastic scattering, incoherent scatter peaks occur at a lower energy than the tube target characteristic X-rays.

inner cuticle margin, *n*—the border between the cortex and the visible cuticle.

inorganic fiber, *n*—a class of fibers of natural mineral origin (for example, chrysotile asbestos) and man-made mineral origin (for example, fiberglass).

interface temperature, *n*—the temperature of the heated zone between the pyrolysis unit and the GC.

interference fringes, *n*—the pattern that results from constructive and destructive interference of light waves.

isotropic, *adj*—a characteristic of an object in which the refractive index remains constant irrespective of the direction of propagation or vibration of the light through the object (**8**).

keratin, *n*—a class of sulfur-containing fibrous proteins that forms the foundation of outgrowth tissue from the epidermis, such as hair, nails, feathers, and horns.

KLM reference lines, *n*—the energies associated with the transitions of the K, L, and M shell electrons.

DISCUSSION—Each element has characteristic energies of transitions of electrons between shells.

knitted fabric, *n*—a structure produced by interlooping one or more ends of yarn or comparable material.

live time, *n*—the time during which an energy dispersive X-ray spectrometer is available to accept and process incoming X-rays.

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

lumen, *n*—the cavity or central canal present in many natural fibers (for example, cotton, flax, ramie, jute, hemp); its presence and structure are often useful aids in identification.

macroscopic, *n*—a term that describes characteristics large enough to be perceived without magnification.

manufactured fiber, *n*—a class name for various genera of fibers (including filaments) produced from fiber forming substances which can be (1) polymers synthesized from chemical compounds [synthetic fibers], (2) modified or transformed natural polymers [regenerated fibers], and (3) minerals, for example, glasses (**7**).

match point, in refractive index measurements, *n*—any combination of temperature and wavelength at which two media have indistinguishable refractive indices. At the match point, the glass will exhibit minimum contrast and visibility.

matrix color, *n*—dominant or background color component of a soil sample, soil aggregate, ped, clod or horizon (adapted from **11**).

medulla, *n*—the core of the hair shaft that is composed of vacuoles and cells that can be air- or fluid-filled.

DISCUSSION—The medulla (if present) occurs in a continuous, discontinuous, or fragmented pattern along the length of a hair and appears translucent or opaque.

Michel-Lévy chart, *n*—a chart relating thickness, birefringence, and retardation so that any one of these variables can be determined when the other two are known (**8**).

microscopical, *adj*—concerning a microscope or the use of a microscope.

microspectrophotometer (MSP), *n*—a specialized spectrophotometer designed to measure the absorbance, reflectance, and emission spectra of microscopic areas on samples.

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

mid-infrared, *n*—pertaining to the IR region of the electromagnetic spectrum with wavelength range from approximately 2.5 to 25 µm (wavenumber range approximately 4000 to 400 cm-1).

mineral, *n*—a naturally occurring inorganic element or compound having an orderly internal structure and characteristic chemical composition, crystal form(s), and physical properties, or an element or chemical compound that is crystalline and that has formed as a result of geological or pedogenic (soil-formed) processes (adapted from **9**).

DISCUSSION—Artificial and biogenic crystalline materials are not minerals but can occur in geological materials (for example, cement powder, lime, lye, biogenic calcite, biogenic hydroxyapatite, bricks) and can be detected by XRD.

modification ratio, *n*—a geometrical parameter used in the characterization of noncircular fiber cross-sections.

DISCUSSION—The modification ratio is the ratio in size between the outside diameter of the fiber and the diameter of the core; it may also be called “aspect ratio.”

monilethrix, *n*—a hair disorder that results in periodic nodes or beading along the length of the hair with intervening, tapering constrictions that are not medullated.

monoaxially oriented polypropylene (MOPP), *n*—an oriented polypropylene film in which the polymer has been stretched in only one direction during the manufacturing process. Tapes with such films can be torn by hand.

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

Munsell color code, *n*—Munsell color is recorded as alpha-numeric Hue Value/Chroma, H V/C (e.g., 7.5YR 5/4 or 5R 6/4); neutral colors, lacking a hue tone, (chroma = 0) are designated with a "hue" of N and omit chroma or list it as zero (N 3/ or N 3/0).

natural fibers, *n*—a class name for various genera of fibers (including filaments) of: (1) animal (that is, silk and wool); (2) mineral (that is, asbestos); or (3) vegetable origin (that is, cotton, flax, jute, and ramie) (**7**).

nonwoven fabric, *n*—a textile structure produced by bonding or interlocking of fibers, or both, accomplished by mechanical, chemical, thermal, or solvent means and combinations thereof.

ovoid bodies, *n*—oval-shaped, heavily-pigmented inclusions usually found in the hair cortex.

phase, *n*—a part of a chemical system that is homogeneous, physically distinct and at least hypothetically separable, and which has single or continuously variable chemical and mechanical properties (adapted from **9**).

phase contrast microscope, *n*—a microscope that translates differences in phase of the light transmitted through the object into differences of intensity in the image — also called phase microscope.

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

pigment aggregation, *n*—clusters of pigment granules.

pigment density, *n*—in hair, the relative abundance of pigment granules in the hair cortex as described along a continuum (for example, sparse, medium, heavy).

pigment distribution, *n*—in hair, the pattern or arrangement of the pigment granules in the hair shaft, such as uniform, peripheral, one-sided, variable, or central.

pili annulati, *n*—a hair disorder causing hairs to appear ringed or banded due to the alternating light and dark bands in the hair shaft; the dark bands are a manifestation of abnormal air spaces in the cortex.

pili torti, *n*—a hair disorder characterized by the hair shaft being flattened and twisted 180 degrees numerous times along its axis; it is usually found at irregular intervals along the shaft.

pixel binning, *v*—the process of combining counts from adjacent pixels in a CCD detector during readout.

plane polarized light, *n*—emitted or observed light in which the electric field vibrates in one direction in a single plane.

plasticizer, *n*—material added to plastics to impart flexibility by creating spaces between the polymer chains and lowering the inter- and intra-chain attractive forces, allowing freer movement of the chains.

DISCUSSION—Plasticizers are used in pressure sensitive backings (particularly PVC) and some adhesives to lower the glass-transition temperature and allow use at sub-ambient temperatures.

polarized light, *n*—a bundle of light rays with a single propagation direction and a single perpendicular vibration direction (**8**).

polish lines, *n*—striation marks produced on the glass surface by polishing.

postmortem root banding, *n*—the appearance of an opaque band near the root/ proximal end of a hair potentially observed in anagen or catagen hairs that have been removed from a decomposing body; the possibility of other conditions causing the same or similar characteristics cannot be eliminated.

prime coat, *n*—a coating of adhesive-like material found between the tape adhesive and backing that serves as a bonding agent.

privileged direction (of a polarizer), *n*—the direction of vibration to which light emerging from a polarizer has been restricted.

DISCUSSION—In modern microscopes, the polarizer's privileged direction is oriented in the east-west direction and the analyzer's privileged direction is oriented in the north-south direction.

provenance, *n*—a place of origin; specifically, the area from which the constituent materials of a sedimentary rock or facies are derived (adapted from **9**).

DISCUSSION—In the context of forensic provenance analysis, geological material is analyzed and interpreted to estimate or limit the geographic or environmental conditions of the source of this material to provide an investigative lead. For example, soil on a shovel can be examined to aid in the search for a clandestine grave, typically by comparison of observations to reference data. Geographic attribution is an alternative term for provenance.

pulse processor time, *n*—operator-selected value for the time designated to record a response by the detector.

DISCUSSION—A higher value (longer time) results in a more accurate determination of the detector amplifier pulse height (better spectral resolution). A lower value results in a higher count rate but with reduced spectral resolution.

pyrogram, *n*—a chromatogram obtained from the pyrolysis products of a material.

pyrolysis, *n*—the thermal fragmentation of a substance in an inert atmosphere.

pyrolysis temperature, *n*—the temperature (set or ramped) at which the pyrolysis of the sample is performed.

pyrolyzate, *n*—the product of the pyrolysis process.

radial fractures, *n*—fracture features extending outward from the point of impact.

raster, *n*—the pattern scanned by the electron beam on a sample; the raster dimensions change inversely with magnification.

ream, *n*—linear distortions as a result of non-homogeneous layers of flat glass.

refraction, *n*—the deflection from a straight path undergone by a light ray in passing obliquely from one medium (as air) into another (as glass) in which its velocity is different.

refractive index, *n*—the ratio of the velocity of light in a vacuum to the velocity of light in some medium (**8**).

reinforcement, *n*—fabric (scrim), glass filaments, or plastic filaments added to tape to impart stability and strength.

release coat, *n*—an inert material with a low surface energy, applied to a backing film on the side opposite the adhesive, that provides ease of unwind and prevents delamination or tearing.

Rietveld refinement, *n*—a procedure for carrying out a crystal-structure refinement using X-ray or neutron powder diffraction data, in which an entire powder pattern is simulated for a trial structure(s) and matched against the observed powder pattern; atomic parameters and other variables are modified to achieve an acceptable fit between the calculated and observed powder patterns (adapted from **9**).

root, *n*—the structure that anchors a hair to a follicle and from which cells divide and produce the hair shaft.

DISCUSSION—The portion of follicular tissue surrounding a root structure is the sheath.

rope, *n*—a compact and flexible, torsionally balanced structure produced from strands which are laid, plaited, or braided together to produce a product which serves to transmit a tensile force between two points (adapted from **1**).

DISCUSSION—Generally greater than 3⁄16 in. diameter; a rope is made up of three or more strands.

rouge pits, *n*—defects on the glass surface containing residual polishing material.

scales, *n*—overlapping, plate-like structures composed of keratin that form the cuticle.

scanning electron microscopy (SEM), *n*—a type of electron microscope in which a focused electron beam is scanned in a raster on a solid sample surface; the term can also include the analytical technique of energy dispersive X-ray spectroscopy.

scarp, *n*—subtle curved line on a fracture surface caused by interaction of a propagating crack and a liquid or a reactive environment (**10**).

scrim count, *n*—the number of warp yarns per inch versus the number of fill yarns per inch.

scrim, *n*—a loosely-woven gauze-type fabric added to duct tape for reinforcement and to impart strength.

secondary electron (SE) imaging, *n*—imaging using low-energy electrons produced from the interaction of beam electrons and conduction band electrons of atoms within the interaction volume, with only those near the surface having sufficient energy to escape.

selvage, *n*—the woven edge portion of a fabric parallel to the warp.

shaft, *n*—the portion of the hair emerging from the hair follicle.

shaft form, *n*—the shape of the hair both longitudinally (for example, curly, straight) and cross-sectionally (for example, round, flattened).

shaft thickness, *n*—the diameter of the hair.

DISCUSSION—This is expressed either numerically or in relative terms, such as fine, medium, or coarse.

shouldering, *n*—a variation of the hair form along the shaft, resulting in an irregular and often asymmetrical change of cross-sectional shape.

soil, *n*—sediments or other unconsolidated accumulations of solid particles (for example, minerals and organic matter) that are produced by the physical, chemical, and biological disintegration of parent material, or which has the ability to support rooted plants.

DISCUSSION—"soil" includes native soil, as well as unconsolidated material emplaced by human activities (adapted from **12**).

soil core sampler [soil corer; soil probe], *n*—a device used to collect virtually undisturbed sub-surface soil samples for documenting a soil profile.

soil horizon, *n*—a layer of soil or soil material approximately parallel to the land surface and differing from adjacent genetically related layers in physical, chemical, and biological properties or characteristics such as color, structure, texture, consistency, kinds and numbers of organisms present, degree of acidity or alkalinity, etc (**12**).

soil profile, *n*—a vertical section of soil exposed from the ground surface to a depth of interest. A soil profile can be observed in a freshly dug pit, along a road bank, or in many other places (adapted from **9**).

somatic region, *n*—an area of the body, such as head, pubic, or leg; synonymous with "body area".

spectral artifacts, *n*—spectral peaks other than characteristic peaks from the sample, produced during the energy dispersive detection process. Examples include escape peaks, sum peaks, tube target coherent and incoherent scatter peaks, system peaks, and diffraction peaks.

spherulites, *n*—spheres composed of needles or rods all oriented perpendicular to the outer surface, or a plane section through such a sphere; a common form of polymer crystallization from melts or concentrated solutions (**2**).

staple, *n*—natural fibers or cut lengths from filaments.

stereomicroscope, *n*—a microscope containing two separate optical paths, one for each eye, giving a three-dimensional view of a specimen.

strand, *n*—(1) a single fiber, filament, or monofilament; (2) an ordered assemblage of textile fibers having a high ratio of length to diameter and normally used as a unit; includes slivers, roving, single yarns, plied yarns, cords, braids, ropes, etc (**7**).

DISCUSSION—A strand is often multiple plies joined together. The terms "ply" and "strand" are not synonymous; cordage can have a single-plied strand, but not a stranded ply.

sub-generic class, *n*—a group of fibers within a generic class that share the same base.

sum peak, *n*—a spectral artifact that results from the simultaneous detection of two X-rays, manifested as a peak at the combined energy of the detected X-rays.

surface dye, *n*—a colorant bound to the surface of a fiber.

synthetic fibers, *n*—a class of manufactured polymeric fibers, which are synthesized from chemical compounds (for example, nylon, polyester).

system peaks, *n*—spectral artifacts that result from the production of characteristic X-rays from structural components of the XRF instrument.

tack, *n*—property of an adhesive that allows it to form a bond immediately with a surface with the application of only slight pressure.

tackifier, *n*—solid resins added to the adhesive base polymer to impart the necessary tack and adhesion.

target fibers, *n*—questioned fibers that an examiner selects for further examination based on their resemblance to the known sample.

technical fiber, *n*—a bundle of natural fibers composed of individual elongated cells that can be physically or chemically separated and examined microscopically for identifying characteristics (for example, hemp, jute, sisal).

telogen, *n*—the resting phase of the hair follicle in the hair growth cycle (**4**).

DISCUSSION—During this phase, the hair has stopped growing and the root becomes keratinized and bulbous (club-like) in shape.

tempering, chemical (toughening), *n*—the process of strengthening glass by ion exchange in which the glass is immersed in a molten salt bath having alkali ions larger than those in the host glass.

tempering, thermal (toughening), *n*—the process of strengthening glass by controlled thermal treatments to create a buildup of surface compressive stresses.

DISCUSSION—Tempering is normally accomplished by rapidly cooling the glass as it emerges from the furnace.

thermal history, *n*—the last set of conditions under which a glass has been cooled from its softened state.

DISCUSSION—Refractive index and density are functions of thermal history.

thermoplastic, *n*—a synthetic material that softens or melts at high temperatures.

thread, *n*—a slender strong strand or cord made by plying or twisting yarns, typically used for stitching.

tip, *n*—*in hair,* the most distal end of a hair shaft.

tracer, *n*—A means of distinguishing one rope from another or one manufacturer from another by the use of yarns, tapes or other markers in a rope, either externally, internally or both. Also referred to as a marker (**1**).

DISCUSSION—This marker can be different in color, size, or composition, or combination thereof, from that of the basic cordage. It can be found in the core or alongside a ply or strand.

trichonodosis, *n*—a condition characterized by apparent or actual knotting of the hair.

trichoptilosis, *n*—a condition characterized by longitudinal splitting or fraying of the hair shaft.

trichorrhexis invaginata, *n*—a genetic disease characterized by a segment of bulbous, dilated hair enfolded into a concave hair terminal, recalling the appearance of a bamboo node; if the hair breaks at the bulbous end, the hair has a “golf-tee” shaped end.

trichorrhexis nodosa, *n*—a condition characterized by the formation of nodes; the hair is weaker at the node and subject to breakage.

trichoschisis, *n*—a condition in which the hair readily breaks or splits along transverse cracks.

twist, *n*—the number of turns about the axis applied to a fiber, yarn, strand or rope over a given length to combine the individual elements into a larger and stronger structure (**1**).

DISCUSSION—The direction of twist in yarns is indicated by the capital letters S and Z. A yarn has an S-twist if, when it is held vertically, the spirals around its central axis slope in the same direction as the middle portion of the letter S, and Z-twist if they slope in the same direction as the middle portion of the letter Z.

ultimates, *n*—individual fibers from a technical fiber.

unit cell, *n*—the smallest group of atoms of a crystal lattice that has the overall symmetry of a crystal of that substance, and from which the entire lattice can be built up by repetition in three dimensions.

wale, *n*—in knitted fabrics, a column of successive loops in the length direction of the fabric; in woven fabrics, one of a series of raised portions or ribs lying warp-wise in the fabric.

Wallner line, *n*—a rib shaped mark with a wavelike contour (also known as “rib marks” or “ripples”).

woven fabric, *n*—a structure produced when at least two sets of strands are interlaced, usually at right angles to each other, according to a predetermined pattern of interlacing, and such that at least one set is parallel to the axis along the lengthwise direction of the fabric.

Keywords

1. analysis; trace evidence; terminology

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