



Designation: ~~C242-00a~~ Designation: C 242 – 01 (Reapproved 2007)

Standard Terminology of Ceramic Whitewares and Related Products¹

This standard is issued under the fixed designation C 242; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This terminology pertains to the terminology used in ceramic whitewares and related products.

1.2 Words adequately defined in standard dictionaries are not included. Included are words that are peculiar to this industry. Double words, hyphenated words, or phrases are listed alphabetically under the first word; additional important words are cross-referenced.

1.3 For definitions of terms relating to surface imperfections on ceramics, refer to Terminology F 109.

2. Referenced Documents

2.1 *ASTM Standards:*²

D 1129 Terminology Relating to Water

E 109 Method for Dry Powder Magnetic Particle Inspection³

~~E 180 Practice for Determining the Precision of ASTM Methods for Analysis and Testing of Industrial Chemicals~~

~~F 109 Terminology Relating to Surface Imperfections on Ceramics- Practice for Determining the Precision of ASTM Methods for Analysis and Testing of Industrial and Specialty Chemicals~~

F 465 Recommended Practice for Developing Precision and Accuracy Data on ASTM Methods Method for the Analysis of Meat and Meat Products³

2.2 *British Standard:*⁴

BS 2955 Glossary of Terms Relating to Powders

3. Terminology

absolute or true density—See *absolute or true density* under **density**.

absorbance—the logarithm of that fraction of an incident light beam that is dissipated in the sample, being neither transmitted nor reflected.

absorbed moisture—water held mechanically in the material and having physical properties not substantially different from ordinary water at the same temperature and pressure.

absorption—(1) the relationship of the weight of the water absorbed by a ceramic specimen, subjected to prescribed immersion procedure, to the weight of the dry specimen.

(2) the capacity of a substance to take up a substance, usually a liquid or gas, with the formation of an apparently homogeneous mixture.

adsorption—the capacity of a substance to accept and retain on its surface a layer of another substance, usually a gas or a liquid.

agglomerate—a jumbled mass or collection of two or more particles or aggregates, or a combination thereof, held together by relatively weak cohesive forces caused by weak chemical bonding or an electrostatic surface charge generated by handling or processing.

DISCUSSION—Common usage in powder technology (and British Standard BS 2955) has the terms “aggregate” and “agglomerate” interchanged in meaning from the definitions presented here, and care must be taken to determine in context which definition is in use.

¹This terminology is under the jurisdiction of ASTM Committee C-21 on Ceramic Whitewares and Related Products and is the direct responsibility of Subcommittee C21.01 on Nomenclature.

Current edition approved June 10, 2000. Published August 2000. Originally published as C242-50F. Last previous edition C242-99a.

²This terminology is under the jurisdiction of ASTM Committee C21 on Ceramic Whitewares and Related Products and is the direct responsibility of Subcommittee C21.01 on Editorial and Terminology.

Current edition approved Nov. 1, 2007. Published January 2008. Originally approved in 1950. Last previous edition approved in 2001 as C 242 – 01.

³For 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*, Vol 11.01, volume information, refer to the standard's Document Summary page on the ASTM website.

³Annual Book of ASTM Standards, Vol 15.05.

³Withdrawn.

⁴Annual Book of ASTM Standards, Vol 15.02.

⁴Available from British Standards Institute, 2 Park St., London, England W1A 2B5.

aggregate—a dense mass of particles held together by strong intermolecular or atomic cohesive forces that is stable to normal mixing techniques, including high-speed stirring and ultrasonics.

alumina porcelain— See *alumina porcelain* under **porcelain**.

alumina whiteware— See *alumina whiteware* under **ceramic whiteware**.

andalusite—a polymorph, along with sillimanite and kyanite, of composition $\text{Al}_2\text{O}_3\cdot\text{SiO}_2$ which on firing dissociates to yield principally mullite.

apparent or pycnometric density—See *apparent or pycnometric density* under **density**.

apparent porosity— See *apparent porosity* under **porosity**.

average particle size—a single value representing the entire particle-size distribution.

DISCUSSION—It is essential to specify the basis under which the average is obtained.

ball clay—a secondary clay, commonly characterized by the presence of organic matter, high plasticity, high dry strength, long vitrification range, and a light color when fired.

ball milling—a method of grinding and mixing material, with or without liquid, in a rotating cylinder or conical mill partially filled with grinding media such as balls or pebbles.

basalt ware—a black unglazed vitreous ceramic ware having the appearance of basalt rock.

Belleek china—a highly translucent whiteware composed of a body containing a significant amount of frit and normally having a luster glaze.

bentonite—a distinct type of fine-grained clay containing not less than 85 % montmorillonite clay having the formula $(\text{OH})_4\text{Si}_8\text{Al}_4\text{O}_{20}\text{nH}_2\text{O}$ and composed of units made up of two silica tetrahedral sheets with a central alumina octahedral sheet.

beryllium oxide (beryllia) (BeO)—an inorganic material of exceptionally high thermal conductivity which is toxic in the powder form.

bias—a constant or systematic error, as opposed to a random error, manifesting itself as a persistent positive or negative deviation of the method average from the accepted reference value. **E 180; F 465**

binder—a cementing medium; either a material added to the mixture to increase the green or dry strength as compacted, and which may be expelled during sintering or calcining, or a material added to a mixture for the purpose of cementing together particles.

DISCUSSION—A binder may be either a permanent addition, or a temporary additive to a ceramic product.

bisque fire—See *bisque fire* under **firing**.

blackbody—the ideal, perfect emitter and absorber of thermal radiation which emits radiant energy at the maximum rate possible, as a consequence of its temperature, and absorbs all incident radiation.

blistering—the development during firing of enclosed or broken macroscopic vesicles or bubbles in a body, or in a glaze or other coating.

bloating—substantial swelling produced by a heat treatment that causes the formation of a vesicular structure.

blunging—the wet process of blending, or suspending ceramic material in liquid by agitation.

body—the structural portion of a ceramic article, or the material or mixture from which it is made.

bone ash—calcined bone consisting essentially of calcium phosphate.

bone china—a translucent china made from a ceramic whiteware body composition containing a minimum of 25 % bone ash.

bright glaze—See *bright glaze* under **glaze**.

calcine—a ceramic material or mixture fired to less than fusion for use as a constituent in a ceramic composition.

capillary action—the phenomenon of intrusion of a liquid into interconnected small voids, pores, and channels in a solid, resulting from surface tension.

cassiterite (SnO_2)—an inorganic mineral of the tetragonal form used as a source of tin and tin oxide.

casting—a process for forming ceramic ware by introducing a body slip into a porous mold which absorbs sufficient water (or other liquid) from the slip to produce a semirigid article.

drain casting (hollow casting)—forming ceramic ware by introducing a body slip into an open porous mold, and then draining off the remaining slip when the case has reached the desired thickness.

solid casting— forming ceramic ware by introducing a body slip into a porous mold which usually consists of two major sections, one section forming the contour of the outside and the other forming the contour of the inside of the ware and allowing a solid cast to form between the two mold faces.

ceramic article—an article having a glazed or unglazed body of crystalline or partly crystalline structure, or of glass, which body is produced from essentially inorganic, nonmetallic substances and either is formed from a molten mass which solidifies on cooling, or is formed and simultaneously or subsequently matured by the action of the heat.

ceramic mosaic tile—an unglazed tile formed by either the dust-pressed or plastic method, usually $\frac{1}{4}$ to $\frac{3}{8}$ in. (6.4 to 9.5 mm) thick, and having a facial area of less than 6 in.² (39 cm²) and which is usually mounted on sheets approximately 1 by 2 ft (0.3 by 0.6 m) to facilitate setting.

DISCUSSION—Ceramic mosaic tile may be of either porcelain or natural clay composition and may be either plain or with an abrasive mixture throughout.

ceramic paste—a French term synonymous with “ceramic body.”

ceramic process—the production of articles or coatings from essentially inorganic, nonmetallic materials, the article or coating being made permanent and suitable for utilitarian and decorative purposes by the action of heat at temperatures sufficient to cause sintering, solid-state reactions, bonding, or conversion partially or wholly to the glassy state.

ceramics—a general term applied to the art or technique of producing articles by a ceramic process, or to the articles so produced.

ceramic whiteware—a fired ware consisting of a glazed or unglazed ceramic body which is commonly white and of fine texture, designating such product classifications as tile, china, porcelain, semivitreous ware and earthenware.

alumina whiteware—any ceramic whiteware in which alumina (Al_2O_3) is an essential crystalline phase.

cordierite whiteware—any ceramic whiteware in which cordierite ($2\text{MgO}\cdot 2\text{Al}_2\text{O}_3\cdot 5\text{SiO}_2$) is the essential crystalline phase.

forsterite whiteware—any ceramic whiteware in which forsterite ($2\text{MgO}\cdot\text{SiO}_2$) is the essential crystalline phase.

steatite whiteware—any ceramic whiteware in which magnesium metasilicate ($\text{MgO}\cdot\text{SiO}_2$) is the essential crystalline phase.

titanium whiteware—any ceramic whiteware in which titania (TiO_2) is the essential crystalline phase.

zircon whiteware—any ceramic whiteware in which zircon ($\text{ZrO}_2\cdot\text{SiO}_2$) is the essential crystalline phase.

chemical porcelain— See *chemical porcelain* under **porcelain**.

china—a glazed or unglazed vitreous ceramic whiteware made by the china process and used for nontechnical purposes, designating such products as dinnerware, sanitary ware, and artware when they are vitreous. (See also **bone china**.)

china clay—See **kaolin**.

china process—the method of producing glazed ware by which the ceramic body is fired to maturity, following which the glaze is applied and matured by firing at a lower temperature.

china sanitary ware (sanitary plumbing fixtures)—glazed, vitrified whiteware fixtures having a sanitary service function.

clay—a natural mineral agglomerate, consisting essentially of hydrous aluminum silicates; plastic when sufficiently wetted, rigid when dried en masse, and vitrified when fired to a sufficiently high temperature.

clear glaze—See *clear glaze* under **glaze**.

closed porosity—See *closed porosity* under **porosity**.

coefficient of friction—the ratio of the parallel component of force required to overcome or have a tendency to overcome the resistance to relative motion of two surfaces in physical contact one with another, but otherwise unconstrained, to the normal component of the force—usually the force as a result of gravity—applied through the object which tends to cause the friction.

color difference—(1) the magnitude and character of the difference between two colors, described by such terms as redder, bluer, lighter, darker, grayer, or cleaner. (2) the magnitude and direction of the difference between a sample and a standard, computed from tristimulus values, or chromaticity coordinates and luminance factor, by means of a specified set of color difference equations.

color space—a three dimensional arrangement for representing all possible colors; for example, in the color space defined by the color scales L , a , and b used to describe the color of opaque specimens, scale L is a measure of lightness, a is a measure of redness (plus) or greenness (minus), and b is a measure of yellowness (plus) or blueness (minus).

color standard—a plaque or other physical standard of established color value, against which standardization of an instrument is made.

DISCUSSION—It may be a reference standard at a calibration laboratory, a transfer standard used to calibrate a particular instrument, or a working standard for routine use.

comminution—the act or process of reduction of particle size with attendant increase in surface area and population of particles, usually but not necessarily by grinding, milling, or pulverizing.

conductive ceramic tile—tile made from special body compositions or by methods that result in specific properties of electrical conductivity while retaining other normal physical properties of ceramic tile.

connected porosity— See *connected porosity* under **porosity**.

cordierite porcelain— See *cordierite porcelain* under **porcelain**.

cordierite whiteware— See *cordierite whiteware* under **ceramic whiteware**.

corundum—a naturally occurring hexagonal mineral of the composition Al_2O_3 , which can also be prepared synthetically to high purity; noted for its hardness (9 on Mohs scale) and refractoriness (M.P. = 2045°C).

DISCUSSION—It forms the gem varieties ruby and sapphire with appropriate impurities. It may contain associated minerals such as diaspore or various silicates, or both. Commonly coarsely crystalline, sometimes microcrystalline.

covering power—the ability of a glaze to cover the surface of the fired ware uniformly and completely.

crawling—a parting and contraction of the glaze on the surface of ceramic ware during drying or firing, resulting in unglazed areas bordered by coalesced glaze.

crazing—the cracking that occurs in fired glazes or other ceramic coatings as a result of tensile stresses. May also occur in the surface portion of uncoated (unglazed) whiteware bodies.

crystalline glaze— See *crystalline glaze* under **glaze**.

deagglomeration—the process of breaking down, usually by physical means, the masses of particles that are held together by relatively weak cohesive forces resulting in a final system of aggregates or primary particles, or both.

deairing—the process of removing entrapped air, or absorbed air from a mass or slurry, usually by application of a vacuum.

decorated—adorned, embellished, or made more attractive by means of color or surface detail.

decorating fire—See *decorating fire* under **firing**.

decoration:

inglaze decoration—a ceramic decoration applied on the surface of an unfired glaze and matured with the glaze.

overglaze decoration—a ceramic or metallic decoration applied and fired on the previously glazed surface of ceramic ware.

polychrome decoration—a multicolor decoration.

underglaze decoration—a ceramic decoration applied directly on the surface of ceramic ware and subsequently covered with a transparent glaze.

deflocculate—to separate agglomerates in a slurry by chemical and physical means to achieve and maintain particle-to-particle separation.

DISCUSSION—A surface-active wetting agent (cationic, anionic, or nonionic type) to coat the particle surface with like ionic charges to induce repulsion of the surfaces is usually effective.

deformation eutectic— See **eutectic, deformation**.

delft ware—a calcareous earthenware having an opaque white glaze and monochrome overglaze decorations. (Originated in Delft, Holland.)

density:

absolute or true density—the weight divided by the volume excluding open and closed pores.

apparent or pycnometric density—the weight divided by the volume excluding open pores, but including closed pores.

tap density—the apparent density of a powdered or granulated material resulting when the receptacle containing the material is vibrated or tapped under standard or specified conditions.

diameter:

arithmetic mean diameter—that diameter located at the centroid of the distribution of size.

equivalent diameter (sphere)—the diameter of a theoretical sphere of a material which under identical physical conditions yields the same value of the particular fineness characteristic as the actual irregularly shaped dispersed particle of the same material.

median diameter— that diameter at which the area under the curve of size versus frequency is divided into two equal parts.

diatomaceous earth— See **diatomite**.

diatomite (diatomaceous earth)—amorphous lightweight siliceous material having the theoretical formula $\text{SiO}_2 \cdot n\text{H}_2\text{O}$, occurring naturally as the fossil remains of tiny plants termed diatoms; also known as *kiesel-guhr*, *tripolite*, and *infusorial earth*.

dinnerware—ceramic whiteware made in a given pattern and in a full line of articles comprising a dinner service.

dispersion—*in a fine particle suspension*, the condition which results when a stable suspension of particles is achieved by physical or chemical means in which no evidence of reflocculation or reagglomeration of the particles is observed.

dolomite—the double carbonate of lime and magnesia having the general formula $\text{CaCO}_3 \cdot \text{MgCO}_3$.

drag—the resistance to shrinkage of the foot or base of a ceramic article during drying or firing as a result of friction with the setter, slab, or sagger on which it rests.

drain casting—See *drain casting* under **casting**.

draining—*in ceramic manufacture*, the process of removing excess slip from dipped or cast items by gravity flow.

dry edging—rough edges and corners of glazed ceramic ware caused by insufficient glaze coating.

drying—removal by evaporation, of uncombined water or other volatile substance from a ceramic raw material or product, usually expedited by low-temperature heating.

dry mix—See *dry process* under **process**.

dry pressing—See *dry pressing* under **pressing**.

dry process—See *dry process* under **process**.

dunting—the cracking that occurs in fired ceramic bodies as a result of thermally induced stresses.

dynamic coefficient of friction—the ratio of the parallel component of force applied to a moving body that maintains constant relative motion of two surfaces in physical contact one with another, but otherwise unconstrained, to the normal component of the force—usually the force caused by gravity—applied to the body under clean, dry conditions.

earthenware—a glazed or unglazed nonvitreous ceramic whiteware.

eggshelling—the texture of a fired glaze similar in appearance to the surface of an eggshell.

electrical porcelain—vitrified whiteware having an electrical insulating function.

embossed—decorated in relief on the surface of the ware.

embossment—a decoration in relief or excised on the ware surface.

emissivity—the ratio of the radiation given off by the surface of a body to the radiation given off by a perfect black body at the same temperature.

engobe—a slip coating applied to a ceramic body for imparting color, opacity, or other characteristics, and subsequently covered with a glaze.

equilibrium eutectic— See **eutectic, equilibrium**.

equivalent diameter (sphere)—See *equivalent diameter (sphere)* under **diameter**.

equivalent spherical diameter—See *equivalent diameter (sphere)* under **diameter**.

eutectic:

deformation eutectic—the composition within a system of two or more components that, on heating under specified conditions, develops sufficient liquid to cause deformation at the minimum temperature.

equilibrium eutectic—the composition within any system of two or more crystalline phases that melts completely at the minimum temperature, or the temperature at which such a composition melts.

faience mosaics—faience tile that are less than 6 in.² (39 cm²) in facial area, usually 5/16 to 3/8 in. (8 to 9.5 mm) thick, and usually mounted to facilitate installation.

faience tile—glazed or unglazed tile, generally made by the plastic process, showing characteristic variations in the face, edges, and glaze that give a handcrafted, nonmechanical, decorative effect.

faience ware—formerly a decorated earthenware with an opaque glaze, but currently designating a decorated earthenware having a transparent glaze.

feldspar—a mineral aggregate consisting chiefly of microcline, albite, or anorthite or combination thereof.

fineness—a measurement number designating the particle size of a material, usually reported as percent passing a screen of a particular standard size.

finer—the portions of a powder composed of particles smaller than a specified size.

fire—See *bisque fire*; *decorating fire*; *glost fire*; *single fire* under **firing**.

firing—the controlled heat treatment of ceramic ware in a kiln or furnace, during the process of manufacture, to develop the desired properties.

bisque fire—the process of kiln-firing ceramic ware before glazing.

decorating fire—the process of firing ceramic or metallic decorations on the surface of glazed ceramic ware.

firing curve—a diagram or table showing the time and temperature planned or experienced by ware going through a firing operation.

firing cycle—the time required for one complete firing operation (cold-to-cold).

firing range—the range of firing temperature within which a ceramic composition develops properties which render it commercially useful.

glost fire—the process of kiln-firing bisque ware to which glaze has been applied.

single fire—the process of maturing an unfired ceramic body and its glaze in one firing operation.

flocculate—a grouping of primary particles, aggregates, or agglomerates having weaker bonding than either the aggregate or agglomerate structures.

DISCUSSION—Flocculates are usually formed in a gas or liquid suspension, and those formed in a liquid can generally be broken up by gentle shaking or stirring.

fluorite (CaF₂) (fluorspar)—an inorganic mineral of the isometric form, used as a source of fluorine for fluxing of glasses, and glazes.

flux—a substance that promotes fusion in a given ceramic mixture.

forming—the shaping or molding of ceramic ware.

forsterite (2MgO·SiO₂)—a magnesium silicate mineral, usually produced synthetically as a ceramic raw material; may be a reaction-produced phase in fired ceramics.

forsterite porcelain— See *forsterite porcelain* under **porcelain**.

forsterite whiteware— See *forsterite whiteware* under **ceramic whiteware**.

free moisture—that water, which is not chemically bound, and that is loosely bound to a material, but which can be removed by drying at 105°C, for a time to achieve constant weight, expressed as a percent of the initial weight of the material.

DISCUSSION—There are a few materials in which chemically bound water volatilizes below 105°C.

friction—the resistance developed between the physical contacting, but otherwise unconstrained, surfaces of two bodies when there is movement or tendency for movement of one body relative to the other parallel to the plane of contact. (See also **coefficient of friction**, **dynamic coefficient of friction**, **in service coefficient of friction**, and **static coefficient of friction**.)

frit—a product made by quenching and breaking up a glass of a specific composition, used customarily used as a component of a glaze, body, or porcelain enamel.

fritted glaze—See *fritted glaze* under **glaze**.

fusion—the process of melting; usually the result of interaction of two or more materials.

glaze—a ceramic coating matured to the glassy state on a formed ceramic article, or the material or mixture from which the coating is made.

bright glaze—a colorless or colored ceramic glaze having high gloss.

clear glaze—a colorless or colored transparent ceramic glaze.

crystalline glaze—a glaze containing macroscopic crystals.

fritted glaze—a glaze in which a part or all of the fluxing constituents are prefused.

leadless glaze—a ceramic coating matured to a glassy state on a formed article, or the material or the mixture from which the

coating is made, to which no lead has been deliberately added.

DISCUSSION—This does not imply that the glaze is nontoxic or that it contains no lead. Because of plant practices and conditions, a small percentage of lead, 0.1 to 0.2 % (by dry weight), expressed as lead monoxide, may be present.

mat glaze—a colorless or colored ceramic glaze having low gloss.

opaque glaze— a nontransparent colored or colorless glaze.

raw glaze—a glaze compounded primarily from raw constituents, that is, containing no prefused materials.

semi-mat glaze— a colorless or colored glaze having moderate gloss.

slip glaze—a glaze consisting primarily of a readily fusible clay or silt.

vellum glaze— a semi-mat glaze having a satin-like appearance.

glazed ceramic mosaic tile—ceramic mosaic tile with glazed faces.

glazed tile—tile with a fused impervious facial finish composed of ceramic materials, fused with the body of the tile which may be a nonvitreous, semivitreous, vitreous, or impervious body resulting in a surface that may be clear, white, or colored.

glazed interior tile—a glazed tile with a body that is suitable for interior use and which is usually nonvitreous, and is not required or expected to withstand excessive impact or be subject to freezing and thawing conditions.

glazed tile, extra duty glaze—tile with a durable glaze that is suitable for light-duty floors and all other surfaces on interiors where there is no excessive abrasion or impact.

glaze fit—the stress relationship between the glaze and body of a fired ceramic product.

glost fire—See *glost fire* under **firing**.

glossy, or bright glaze—a glaze which exhibits essentially full specular reflection.

grindability:

absolute grindability index—a characteristic number expressed as the change in specific surface area of a material per unit of time in a specific comminution system.

relative grindability index—a characteristic number expressed as the change in specific surface area or other criteria such as particle size or fineness of a material per unit of time, mill revolutions or other standard with respect to a known standard sample in a specific comminution system.

DISCUSSION—Grindability is an intrinsic property of material hardness or friability that may be experimentally determined by measuring the change in specific surface area, ΔA_s , generated per unit of grinding time, t ; the grindability index being determined from the slope of the plot of ΔA_s in m^2/g versus grinding time, t , in hours or other unit of time.

healing power—the ability of a glaze to heal surface blemishes during firing.

hollow casting—See *drain casting* under **casting**.

hot pressing—See *hot pressing* under **pressing**.

hue—the attribute of color perception by means of which a color is judged to be red, orange, yellow, green, blue, purple, or intermediate between adjacent pairs of these, considered in a closed ring, red and purple being an adjacent pair (white, gray, and black possess no hue).

ilmeneite—a mineral having the theoretical composition $FeO \cdot TiO_2$ used principally in the production of titanium oxide.

impervious—that degree of vitrification evidenced visually by complete resistance to dye penetration.

DISCUSSION—The term impervious generally signifies zero absorption, except for floor and wall tile which are considered “impervious” up to 0.5 % water absorption.

incised—decorated by cutting or indenting the ware surface.

inglaze decoration— See *inglaze decoration* under **decoration**.

in service coefficient of friction—a coefficient of friction measured under a specified condition of use, which may not be clean and dry, and hence, not a property of the ceramic surface.

DISCUSSION—For example, measurement of a ceramic tile coated with grease is a measurement of the grease-tile system and not a property of the ceramic tile.

ironstone ware—(stone china, white granite ware)—historic terms for a durable English earthenware.

jasper ware—a vitreous, opaque, colored, unglazed ceramic ware having white or contrasting relief decorations and containing a substantial amount of barite.

jiggering—forming ceramic ware from a plastic body by differential rotation of a profile tool and mold, the mold having the contour of one surface of the ware and the profile tool that of the other surface.

kaolin (china clay)—a refractory clay consisting essentially of minerals of the kaolin group and which fires to a white or nearly white color.

knockings—the oversize residue obtained in screening a ceramic slip.

kyanite ($Al_2O_3 \cdot SiO_2$)—the most abundant of the mineral polymorphs that include andalusite and sillimanite, commonly used as a source of mullite in ceramics.

laser light scattering—a phenomenon suitable for the measurement of particle size in that particles illuminated by a collimated