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# Standard Terminology of Ceramic Whitewares and Related Products[1]

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## 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:*

D 1129 Terminology Relating to Water[2]

E 180 Practice for Determining the Precision of ASTM Methods for Analysis and Testing of Industrial Chemicals[3]

F 109 Terminology Relating to Surface Imperfections on Ceramics[4]

F 465 Practice for Developing Precision and Accuracy Data on ASTM Methods for the Analysis of Meat and Meat Products[5]

2.2 *British Standard:*[6]

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 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.

**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 $Al_2O_3 \cdot SiO_2$ 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.

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

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[2] *Annual Book of ASTM Standards*, Vol 11.01.

[3] *Annual Book of ASTM Standards*, Vol 15.05.

[4] *Annual Book of ASTM Standards*, Vol 15.02.

[5] *Annual Book of ASTM Standards*, Vol 15.07.

[6] Available from British Standards Institute, 2 Park St., London, England W1A 2B5.

**bentonite**—a distinct type of fine-grained clay containing not less than 85 % montmorillionite clay having the formula $(OH)_4Si_8Al_4O_{20}nH_2O$ 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 ¼ to ⅜ in. (6.4 to 9.5 mm) thick, and having a facial area of less than 6 $in.^2$ (39 $cm^2$) 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 ($2MgO{\cdot}2Al_2O_3{\cdot}5SiO_2$) is the essential crystalline phase.

*forsterite whiteware*—any ceramic whiteware in which forsterite ($2MgO{\cdot}SiO_2$) is the essential crystalline phase.

*steatite whiteware*—any ceramic whiteware in which magnesium metasilicate ($MgO{\cdot}SiO_2$) is the essential crystalline phase.

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

*zircon whiteware*—any ceramic whiteware in which zircon ($ZrO_2{\cdot}SiO_2$) 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 tendancy 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) whitewares 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 $SiO_2 \cdot nH_2O$, 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 $CaCO_3 \cdot MgCO_3$.

**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 $cm^2$) 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 handicrafted, 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.

**fines**—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 ($CaF_2$) (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 ($2MgO \cdot SiO_2$)**—a magnesium silicate mineral, usually produced synthetically as a ceramic raw material; may be a reaction-produced phase in fired ceramics.

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

*forsterite whiteware*—See *fosterite 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 tendancy 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.**

**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, $\Delta A_s$, generated per unit of grinding time, $t$; the grindability index being determined from the slope of the plot of $\Delta A_s$ 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.**

**ilmenite**—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 laser beam cause the light to be scattered through angles which are inversely proportional to the size (generally expressed as a diameter) of the particles.

*leadless glaze*—See *leadless glaze* under **glaze**.

**limestone**—a sedimentary carbonate rock, composed chiefly of calcite ($CaCO_3$), but sometimes containing appreciable dolomite.

**liquid suspension**—the system resulting from the intimate, physical mixing of a liquid and particulate solids or dispersable materials, to form a time-stable, uniform, fluid mixture.

**loss on ignition**—the percent loss in weight of a material on being calcined at a temperature sufficiently high, and for a time long enough, to achieve constant weight without melting, expressed as a percent of the initial weight of the dry material (without free moisture).

**magnesia**—magnesium oxide (MgO), calcined or hard burned as periclase loosely applied also to the hydrate $Mg(OH)_2$, and made synthetically from seawater or brine, or (impure) from magnesite.

**majolica**—formerly an earthenware with an opaque luster glaze and overglaze colored decorations, but currently designating any decorated earthenware having an opaque glaze.

**major tile facial dimensions**—the overall length or width of the tile, including the lugs on opposite sides.

**major tile thickness**—the thickness of tile, including any maximum protuberances or ridges on the back.

**masking power**—the ability of a fired glaze to mask visually the body on which it is applied.

*mat glaze*—See *mat glaze* under **glaze.**

**maturing range**—the time-temperature range within which a ceramic body, glaze, or other composition may be fired to yield specified properties.

**mean coefficient of thermal expansion, α (mm/mm·°C or in./in.·°C)**—from temperature $T_1$ to temperature $TT_1 < T_2$):

$$\alpha = \frac{0.01P}{T_2 - T_1} \quad (1)$$

where $P$ = percent linear thermal expansion, as defined below.

*mean diameter, arithmetic*—See *arithmetic mean diameter* under **diameter.**

*median diameter*—See *median diameter* under **diameter.**

**melt**—to change a solid into a liquid by the application of heat; or the liquid resulting from such action.

**mineralizer**—a processing additive that promotes either the recrystallization or the partial fusion or sintering of certain mineral or ceramic materials, often facilitating the desired conversion at a lower temperature.

**minor tile facial dimension**—the length or width of the tile exclusive of the lugs.

**minor tile thickness**—the thickness of tile that does not include maximum protuberances or ridges.

**moisture expansion**—an increase in dimension or bulk volume of a ceramic article caused by reaction with water or water vapor.

DISCUSSION—This reaction may occur in time at atmospheric temperature and pressure, but is expedited by exposure of the article to water or water vapor at elevated temperatures and pressures.

**monochrome decoration**—a single color decoration.

**mottling**—the presence in the surface of a glaze or body of irregularly shaped, randomly distributed areas that vary in color, gloss, or sheen causing the surface to be nonuniform in appearance.

**mullite**—a rare mineral of theoretical composition $3Al_2O_3 \cdot 2SiO_2$, a relatively stable phase in ceramics produced by the high temperature reaction of alumina and silica or by the thermal decomposition of alumina-silica minerals such as kyanite, sillimanite, andalusite, and various clay minerals.

**mullite porcelain**—a vitreous ceramic whiteware for technical application in which mullite ($3Al_2O_3 \cdot 2SiO_2$) is the essential crystalline phase.

**mullite whiteware**—any ceramic whiteware in which mullite ($3Al_2O_3 \cdot 2SiO_2$) is the essential crystalline phase.

**natural clay tile**—a tile made by either the dust-pressed method or the plastic method, from clays that produce a dense body having a distinctive, slightly textured appearance.

**nepheline syenite**—a mineral aggregate consisting chiefly of albite, microcline, and nephelite, each in significant amount.

**nonplastic ceramics**—nonclay ceramic materials that when mixed with water do not exhibit the rheological property-plasticity.

**nonvitreous (nonvitrified)**—that degree of vitrification evidenced by relatively high water absorption.

DISCUSSION—The term nonvitreous generally signifies more than 10.0 % water absorption, except for floor and wall tile which are considered nonvitreous when water absorption exceeds 7 %.

*opaque glaze*—See *opaque glaze* under **glaze.**

*open porosity*—See *open porosity* under **porosity.**

**orangepeel**—a pitted texture of a fired glaze resembling the surface of rough orange peel.

**oven ware**—ceramic whiteware for culinary oven use.

*overglaze decoration*—See *overglaze decoration* under **decoration.**

**particle**—a minute quantity or fragment of matter whose size and shape depend on the forces of cohesion. It is usually only a single crystal or a unit of matter with a specific gravity approximating that of a single crystal.

**particle shape**—a characterization of the shape or configuration of a particle fitting it into any one of ten basic classes, as follows:

| Class | |
|---|---|
| A | acicular—needle shaped |
| B | angular—sharp-edged or having roughly polyhedral shape |
| C | crystalline—of geometric shape freely developed |
| D | dendritic—having a branched crystalline shape |
| E | fibrous—regularly or irregularly threadlike |
| F | flakey—lamellar, plate-like |
| G | granular—having an approximately equidimensional but irregular shape |
| H | irregular—lacking any symmetry |
| I | nodular—having a rounded irregular shape |
| J | spherical—globule shaped |

*particle size*—See **average particle size.**

**particle-size distribution**—a profile of the sizes of particles contained in a material in which the quantities must be expressed on some basis which may be total number, total surface, or total weight or volume of the particles in the material.

**paste**—a prepared mixture consisting of a suspension of undissolved solid(s) in a liquid medium sufficiently viscous that it cannot achieve a level surface without application of external force; not a slurry.

**pate dure (hard paste)**—a French term designating ceramic whitewares fired at relatively high temperatures.

**pate tendre (soft paste)**—a French term designating ceramic whitewares fired at relatively low temperatures.

**pavers**—unglazed porcelain or natural clay tile formed by the dust-pressed method and similar to ceramic mosaics in composition and physical properties but relatively thicker with 6 $in.^2$ (39 $cm^2$) or more of facial area.

*peeling*—See **orangepeel; shivering.**

**percentile**—one of the values in a series dividing the distribution of the variable in the series into 100 groups of equal frequency or size.

**percent linear thermal expansion**—the change in length per unit length as temperature is changed from temperature $T_1$ to temperature $T_2 (T_1 < T_2)$, expressed as a percent:

$$P = [(L_2 - L_1)/L_o] \times 100 + A \quad (2)$$

where:

$L_o$ = sample length at $T_o$ (between 20 and 30°C),
$L_1$ = sample length at $T_1$,
$L_2$ = sample length at $T_2$, and
$A$ = instrument correction.

**permeability**—the measure through a material of fluid flow, gas, or liquid.

**petalite**—a lithium mineral of theoretical composition $Li_2O \cdot Al_2O_3 \cdot 8SiO_2$ which transforms on heating to a beta spodumene-silica solid solution product of very low or nil thermal expansion.

**photosedimentation**—a technique of fine particle measurement wherein the size and number (or volume) of particles in a sedimenting suspension are determined by the effect of the presence of sedimenting particles on the intensity of a beam of light or X-ray or laser beam transmitted through the suspension as a function of settling time of the particles.

**photozone counter**—a stream counter in which the interrogation zone is monitored for changes in a light signal because of the presence of a particle.

**pinholes**—imperfections in the surface of a ceramic body or glaze resembling pin pricks.

**plastic**—a descriptive term applied to a material that exhibits the property of plasticity or stickiness, where plasticity is the ability of a material to undergo substantial deformation without fracturing.

*plastic pressing*—See wet pressing under **pressing.**

*polychrome decoration*—See *polychrome decoration* under **decoration**.

**porcelain**—a glazed or unglazed vitreous ceramic whiteware made by the porcelain process, and used for technical purposes, designating such products as electrical, chemical, mechanical, structural, and thermal wares when they are vitreous.

*alumina porcelain*—a vitreous ceramic whiteware for technical application in which alumina ($Al_2O_3$) is an essential crystalline phase.

*chemical porcelain*—vitreous ceramic whitewares used for containing, transporting, or reacting of chemicals.

*cordierite porcelain*—a vitreous ceramic whiteware for technical application in which cordierite ($2MgO \cdot 2Al_2O_3 \cdot 5SiO_2$) is the essential crystalline phase.

*forsterite porcelain*—a vitreous ceramic whiteware for technical application in which forsterite ($2MgO \cdot SiO_2$) is the essential crystalline phase.

*steatite porcelain*—a vitreous ceramic whiteware for technical application in which magneisum metasilicate ($MgO \cdot SiO_2$) is the essential crystalline phase.

*titania porcelain*—a vitreous ceramic whiteware for technical application in which titania ($TiO_2$) is the essential crystalline phase.

*zircon porcelain*—a vitreous ceramic whiteware for technical application in which zircon ($ZrO_2 \cdot SiO_2$) is the essential crystalline phase.

**porcelain process**—the method of producing glazed ware by which a ceramic body and glaze are matured together in the same firing operation.

**porcelain tile**—a ceramic mosaic tile or paver that is generally made by the dust-pressed method of a composition resulting in a tile that is dense, fine-grained, and smooth with sharply formed face, usually impervious and having colors of the porcelain type which are usually of a clear, luminous type or granular blend thereof.

**porosity**—the volume fraction of voids contained in a solid, often expressed as a percent.

DISCUSSION—It has meaning only for a consolidated form of solid, whether that be a particle, agglomerate, grain, or formed object such as nodule, pellet, or larger monolithic mass. Since pores can be described in various specific ways, there is an equal number of corresponding expressions for porosity: macroporosity, microporosity, open or apparent porosity, connected porosity, closed or blind porosity, and total porosity, the sum of open and closed porosity. Porosity may also be expressed as determined by a given instrument or technique, for example, mercury porosimetry, which approximates open porosity, or water absorption, which also approximates open porosity.

*closed porosity*—the volume fraction of all pores within a solid mass that are closed off by surrounding solid and, hence, are inaccessible to each other and to the external surface: they thus are not detectable by gas or liquid penetration.

*connected porosity*—the volume fraction of all pores, voids, and channels within a solid mass that are interconnected with each other.

*open porosity*—the volume fraction of all pores, voids, and channels within a solid mass that are interconnected with each other and communicate with the external surface, and thus are measurable by gas or liquid penetration (Syn. *apparent porosity*).

*porosity, apparent*—See *open porosity* under **porosity.**

**pottery**—all fired ceramic wares that contain clay when formed, except technical, structural, and refractory products.

**precision**—the agreement of repeated measurements of the same parameter expressed quantitatively as the standard deviation computed from the results of a series of controlled determinations. **D 1129**

**pressing:**

*dry pressing*—forming ceramic ware in dies from powdered or granular material by direct pressure.

*hot pressing*—a jiggering process wherein a heated profile tool or plunger is used.

*wet pressing (plastic pressing)*—forming ceramic ware in dies from a plastic body by direct pressure.

**primary clay (residual clay)**—a clay that remains geologically at its site of formation.

**process:**

*dry process (dry mix)*—the method of preparation of a ceramic body wherein the constituents are blended dry, following which liquid may be added as required for subsequent processing.

*wet process (slip process)*—the method of preparation of a ceramic body wherein the constituents are blended in sufficient liquid to produce a fluid suspension for use as such or for subsequent processing.

**pyrophyllite**—a hydrated aluminum silicate mineral of the theoretical composition $Al_2O_3 \cdot 4SiO_2 \cdot H_2O$, having physical properties in the raw state resembling mineral talc.

**quarry tile**—glazed or unglazed tile, made by the extrusion process from natural clay or shale usually having 6 $in.^2$ (39 $cm^2$) or more of facial area.

*raw glaze*—See *raw glaze* under **glaze.**

**repeatability**—the standard deviation of results obtained by the same operator using the same instrument in successive measurements on the same sample.

**reproducibility**—the standard deviation of results obtained by different operators using the same or different instruments in different laboratories on the same sample.

**resistazone counter**—the generic name used to describe stream counters in which the interrogation zone is monitored for changes in electrical resistance as a result of the presence of a particle.

**Rockingham ware**—a semivitreous ware or earthenware having a brown or mottled brown bright glaze.

**rutile**—a mineral form of titanium oxide ($TiO_2$) (tetragonal crystallization), but usually produced chemically for use in ceramics and other products.

**salt glaze**—a glaze produced by the reaction, at elevated temperature, between the ceramic body surface and salt fumes produced in the kiln atmosphere.

*sanitary ware*—See **china sanitary ware.**

**secondary clay (sedimentary clay)**—a clay that has been geologically transported from its place of formation.

*semi-mat glaze*—See *semi-mat glaze* under **glaze.**

**semi-porcelain**—a trade term designating semivitreous dinnerware.

**semivitreous (semivitrified)**—that degree of vitrification evidenced by a moderate or intermediate water absorption.

DISCUSSION—The term semivitreous generally signifies 0.5 to 10.0 % water absorption, except for floor and wall tile which are considered semivitreous when water absorption is between 3.0 and 7.0 %.

**shape factor**—a dimensionless ratio of lengths, surface areas, or volumes of the particles, useful for characterizing or comparing particles that otherwise have similar physical properties.

**ship and galley tile**—a special quarry tile having an indented pattern on the face of the tile to produce an antislip effect.

**shivering (peeling)**—the splintering that occurs in fired glazes or other ceramic coatings as a result of critical compressive stresses.

**sieve**—a standard wire mesh or screen, especially when used in graded sets to determine the mesh size or particulate size distribution of particulate or granular solids.

**sieve analysis**—the particle size distribution of a particulate or granular solid or sample thereof, when determined by weight percent passage through, or retention on, a graded set of sieves.

**silica ($SiO_2$)**—the common oxide of silicon usually found naturally as quartz or in complex combination with other elements as silicates.

DISCUSSION—Various polymorphs and natural occurrences of silica include cristobalite, tridymite, cryptocrystalline chert, flint, chalcedony, and hydrated opal.

*sillimanite*—See **andalusite.**

*single fire*—See *single fire* under **firing.**

**sinter**—a ceramic material or mixture fired to less than complete fusion, resulting in a coherent mass, or the process involved.

**size**—the representative dimension that best describes the extent in space of a particle, agglomerate, or aggregate.

DISCUSSION—This term is not recommended to be used by itself. For example, use, Martin's diameter or Stokes' diameter.

**slip**—a slurry containing chemical additives to control rheology.

*slip casting*—See *drain casting* and *solid casting* under **casting.**

**slip coating**—a ceramic material or mixture other than a glaze, applied to a ceramic body and fired to the maturity required to develop specified characteristics.

*slip glaze*—See *slip glaze* under **glaze.**

*slip process*—See *wet process* under **process.**

**slip resistance**—the frictional force opposing movement of an object across a surface.

**slurry**—a prepared mixture consisting of a free-flowing suspension of undissolved solid(s) in a liquid medium; not a paste.

**smelt (*n*)**—a specific batch or lot of frit.

(*v*)—the act of melting a batch of frit.

**smelter**—a furnace in which the raw materials of a frit batch are melted.

*solid casting*—See *solid casting* under **casting**.

**special-purpose tile**—a tile, either glazed or unglazed, made to meet or to have specific physical design or appearance characteristics such as size, thickness, shape, color, or decoration; keys or lugs on backs or sides; special resistance to staining, frost, alkalies, acids, thermal shock, physical impact, high coefficient of friction, or electrical properties.

**spitout**—a glaze defect of the pinhole type developed in the decorating kiln, as a result of the evolution of minute gas bubbles from body or glaze.

**spodumene (alpha spodumene)**—a lithium mineral of the theoretical composition $Li_2O{\cdot}Al_2O_3{\cdot}4SiO_2$ (monoclinic crystallization) which on heating inverts to beta spodumene, a form having very low or nil thermal expansion.

**static coefficient of friction**—the ratio of the parallel component of force applied to a stationary body that just overcomes the friction or 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 caused by gravity—applied to the body under clean, dry conditions.

*steatite porcelain*—See *steatite porcelain* under **porcelain.**

**steatite talc**—massive talc or the pulverized product thereof having the general formula $3MgO{\cdot}4SiO_2{\cdot}H_2O$.

*steatite whiteware*—See *steatite whiteware* under **ceramic whiteware.**

**stoneware**—a vitreous or semivitreous ceramic ware of fine texture, made primarily from nonrefractory fire clay.

**stream counter**—an instrument in which the particles to be characterized are presented to an interrogation zone as a one-dimensional stream, the size of the particle being deduced from the physical changes it causes in the interrogation zone. (See also **resistazone** and **photozone**.)

**substrate**—a body, board, or layer of material on which some other active or useful material or component may be deposited or laid, as for example, an electronic circuitry laid on an alumina ceramic board.

**surface area**—the total area of the surface of a powder or solid including both external and accessible internal surfaces (from voids, cracks, open porosity, and fissures).

DISCUSSION—The area may be calculated by the B.E.T. (Brunauer, Emmett, and Teller) equation from gas adsorption data obtained under specified conditions. It is useful to express this value as the specific surface area, for example, surface area per unit weight of sample ($m^2/g$).

*suspension, liquid*—See **liquid suspension.**

**tableware**—all utensils and decorative articles used on the table for meal service.

**tailings**—the (size) residue, coarse or fine, removed from a separation process.

**talc**—a phyllosilicate mineral having the general formula $3MgO{\cdot}4SiO_2{\cdot}H_2O$ and noted for its extreme softness, low thermal and electrical conductivity, and fire resistance. (See also **steatite talc.**)

*tap density*—See *tap density* under **density.**

**terra sigillata**—a porous, red clay ware characterized by embossed decorations of the same color and a satin-like unglazed surface.

*thermal expansion*—See **mean coefficient of thermal expansion; percent linear thermal expansion.**

**thermal shock**—a condition of stress brought about by a large temperature difference across a body or glaze. (See also **thermal shock failure; thermal shock resistance testing.**)

DISCUSSION—Do not confuse thermal shock with phase change shock.

**thermal shock failure**—mechanical failure of a glaze or body, as a result of the stress caused by a large temperature difference across the ware.

**thermal shock resistance testing**—the act of exposing ware to a rapid temperature change to determine the temperature difference a glaze or body can withstand without mechanical failure.

$$\Delta T_{max} = \sigma / T\alpha \quad (3)$$

where:

$\sigma$ = stress,
$E$ = Young's Modulus, and
$\alpha$ = mean coefficient of thermal expansion.

**tile**—a ceramic surfacing unit, usually relatively thin in relation to facial area, made from clay or a mixture of clay and other ceramic materials, called the body of the tile, having either a "glazed" or "unglazed" face and fired above red heat in the course of manufacture to a temperature sufficiently high to produce specific physical properties and characteristics. (See also **ceramic mosaic tile; conductive ceramic tile; faience tile; glazed ceramic mosaic tile; glazed interior tile; glazed tile; glazed tile, extra duty glaze; major tile facial dimensions; major tile thickness; minor tile facial dimension; minor tile thickness; porcelain tile; unglazed tile; wedging of tile.**)

**tin oxide ($SnO_2$)**—in finely ground form used in glazes as an opacifier.

*titania porcelain*—See *titania porcelain* under **porcelain.**

*titania whiteware*—See *titania whiteware* under **ceramic whiteware.**

**trimmers**—units of various shapes consisting of such items as bases, caps, corners, mouldings, angles, and so forth, necessary or desirable to make a complete installation and to achieve sanitary purposes as well as architectural design for all types of tile work.

*underglaze decoration*—See *underglaze decoration* under **decoration.**

**unglazed tile**—a hard, dense tile of homogeneous composition throughout, deriving color and texture from the materials of which the body is made. The colors and characteristics of the tile are determined by the materials used in the body, the method of manufacture, and the thermal treatment.

*vellum glaze*—See *vellum glaze* under **glaze.**

**viscosity**—the property of fluids that opposes the relative motion of adjacent portions of a given fluid producing a type of internal friction and exhibiting a resistance to flow.

**vitreous (vitrified)**—that degree of vitrification evidenced by low water absorption. (See also **impervious; nonvitreous; semivitreous.**)

DISCUSSION—The term vitreous generally signifies less than 0.5 % absorption, except for floor and wall tile and low-voltage electrical porcelain which are considered vitreous up to 3.0 % water absorption.

**vitreous slip**—a slip coating matured on a ceramic body producing a vitrified surface.

**vitrification**—the progressive reduction and elimination of porosity of a ceramic composition, with the formation of a glass phase, as a result of heat treatment.

**vitrification range**—the maturing range of a vitreous body.

**void space**—ratio of the volume of voids in a powder bed to that of the overall volume of the powder bed.

**warpage**—curvature of a flat specimen measured as deviation of the specimen surface from a true plane along the edges or the diagonals and at the mid-length of an edge or diagonal, expressed as a percent of the length of the edge or diagonal, and called convex or concave with respect to the face of the specimen.

**water of hydration or combined water**—that water in a material that cannot be removed by drying at 110°C, as it is chemically bound, expressed as a percent of the weight of the material.

**wedging of tile**—the difference between two spaced measurements of the length or width of a tile, expressed as a percent of the distance between points of measurement.

**wetting agent**—a chemical additive that reduces the surface tension of a fluid, inducing it to spread readily on a surface to which it is applied, thus causing wetting of the surface of the solid with the fluids.

*wet pressing*—See *wet pressing* under **pressing.**

*wet process*—See *wet process* under **process.**

*whiteware*—See **ceramic whiteware.**

**whiting**—calcium carbonate powder of high purity.

**wollastonite**—a calcium metasilicate mineral with the formula $CaSiO_3$ containing theoretically 48.3 % lime (CaO) and 51.7 % silica ($SiO_2$), occurring in acicular masses of elongated triclinic crystals, usually white or pale gray.

**yellow ware**—a yellow semivitreous ware or an earthenware with a colorless, clear glaze.

**Zahn cup**—an apparatus for the measurement of liquid or slurry viscosity expressed as the number of seconds required for the liquid or slurry to drain from the cup through a hole of definite diameter.

*zircon porcelain*—See *zircon porcelain* under **porcelain.**

*zircon whiteware*—See *zircon whiteware* under **ceramic whiteware.**