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Standard Terminology Relating to Porcelain Enamel and Ceramic-Metal Systems¹

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This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 These definitions pertain to the terminology used in the porcelain enamel and ceramic-coated metal industries.

1.2 Words adequately defined in standard dictionaries are not included. Included are words that are peculiar to these industries.

1.3 Hyphenated words, double words, or phrases are listed alphabetically under the first word; additional important words are cross-referenced.

1.4 When a word or phrase, listed as a synonym, is not separately defined, the defined word or phrase is the accepted or preferred form.

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

2. Referenced Documents

- 2.1 *ASTM Standards:*²
- A424 Specification for Steel, Sheet, for Porcelain Enameling
 - B487 Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of Cross Section
 - B915 Test Method for Measuring Static Heat Resistance of Self-Cleaning Oven Coating
 - B916 Test Method for Adherence of Porcelain Enamel Coatings to Sheet Metal
 - C282 Test Method for Acid Resistance of Porcelain Enamels (Citric Acid Spot Test)

- C283 Test Methods for Resistance of Porcelain Enameled Utensils to Boiling Acid
- C285 Test Methods for Sieve Analysis of Wet-Milled and Dry-Milled Porcelain Enamel
- C346 Test Method for 45-deg Specular Gloss of Ceramic Materials
- C374 Test Methods for Fusion Flow of Porcelain Enamel Frits (Flow-Button Methods)
- C385 Test Method for Thermal Shock Resistance of Porcelain-Enameled Utensils
- C448 Test Methods for Abrasion Resistance of Porcelain Enamels
- C614 Test Method for Alkali Resistance of Porcelain Enamels
- C633 Test Method for Adhesion or Cohesion Strength of Thermal Spray Coatings
- C743 Test Method for Continuity of Porcelain Enamel Coatings
- C756 Test Method for Cleanability of Surface Finishes
- C774 Test Method for Yield Strength of Enameling Steels After Straining and Firing
- D523 Test Method for Specular Gloss
- D2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
- D4060 Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser

3. Terminology

abrasion resistance, n —the degree to which a porcelain enamel will resist attack by abrasive materials.

NOTE 1—See Test Methods C448 and D4060.

acid resistance, n —the degree to which a porcelain enamel will resist attack by acids.

NOTE 2—See Test Methods C283 and C282.

adherence, n —(1) the degree of adhesion of a porcelain enamel or other ceramic coating to a metal substrate.

NOTE 3—See Test Method B916.

(2) Stress necessary to cause separation of one material from another at their interface.

NOTE 4—See Test Method C633.

¹ This terminology is under the jurisdiction of ASTM Committee B08 on Metallic and Inorganic Coatings and is the direct responsibility of Subcommittee B08.12 on Materials for Porcelain Enamel and Ceramic-Metal Systems.

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

aging, *n*—the storing of porcelain enamel slips or powders before use. The change occurring in slips or powders with the lapse of time.

air atomizing, *n*—air used to atomize powder and to control powder/air mix and powder cloud density.

air fluidizer, *n*—air used to impart fluid-like properties to powder via a fluid bed.

alkali resistance, *n*—*for porcelain enamels*, the degree to which a porcelain enamel will resist attack by aqueous alkaline solutions.

NOTE 5—See Test Method C614.

alligator hide, *n*—a defect characterized by an extreme roughness of the porcelain enamel surface: a severe case of orange peel.

aluminum enamel, *n*—a porcelain enamel specifically designed for application to aluminum.

anti-scale compound, *n*—a preparation that is applied to burning tools to protect them from scaling in service.

back emission, *n*—the electrical breakdown of air due to excessive charge build-up in the porcelain enamel powder film during powder application. This is due to the self-limiting characteristic of electrostatic powders.

back ionization, *n*—see **back emission**.

ball mill, *n*—*in porcelain enamels*, a dense, ceramic-lined rotating cylinder in which ceramic materials are wet or dry ground, generally using pebbles or porcelain balls as grinding media.

base coat, *n*—for two coat-one fire application, the thin layer of bonding frit applied first and used to promote adherence after firing to the metal substrate.

base metal, *n*—the metal to which porcelain enamel is applied.

basis metal—see **base metal**.

basket, pickle—see **pickle basket** and **pickling**.

batch smelter, *n*—any smelter that operates as a periodic unit, being charged, fired, and discharged according to a predetermined cycle.

beading, *n*—(1) the application of porcelain enamel, usually of a contrasting color, to the edge or rim of porcelain enameled articles.

(2) Removal of excess slip from the edge of dipped ware.

(3) In dry processing enameling, a bead of porcelain enamel along the edge of ware.

beading enamel, *n*—any of the special porcelain enamels used for beading.

bisque, *n*—a coating of wet-process porcelain enamel that has been dried, but not fired.

blackboard enamel— see **chalkboard enamel**.

black edging, *n*—a black porcelain enamel applied over the ground coat and exposed in specified areas by brushing the cover coat bisque prior to firing (see also **edging**).

black speck, *n*—a defect that appears in the fired cover coat as a small dark spot.

blank, *n*—the piece cut from metal sheet that is to be used in forming the finished article.

blemish, *n*—*in dry process enameling*, an insignificant imperfection in the porcelain enamel surface.

blister, *n*—a defect caused by gas evolution consisting of a bubble that forms during fusion and remains when the porcelain enamel solidifies.

blow-off resistance, *n*—the degree to which a deposited layer of powder resists being blown off by a standard jet of air.

blue enamel, *n*—(1) *in dry-process porcelain enameling*, an area of enamel coating so thin that it appears blue in color.

(2) *In wet-process enameling*, a cover coat applied too thin to hide the substrate.

boiling, *n*—a defect visible in the fired porcelain enamel caused by gas evolution which results in the formation of blisters, pinholes, black specks, dimples, or spongy surface.

bolt-hole brush, *n*—a special round brush used to remove porcelain enamel bisque from in and around small openings in the ware.

bond, *n*—see **adherence**.

box furnace—a furnace in which, periodically, a load of ware is introduced, fired, and removed.

break out, *n*—*in dry process enameling*, a defect characterized by an area of blisters with well defined boundaries.

brush, *v*—to remove bisque in a definite pattern by means of a brush.

brush, bolt-hole, *n*—see **bolt-hole brush**.

brushing, *v*—see **brush**.

bubble structure, *n*—size and spatial distribution of voids within the fired porcelain enamel.

buck, *n*—a special support for ware during the firing of porcelain enamel on heavy ware.

burning, *n*—see **firing**.

burning bars, points, or tools, *n*—equipment used to suspend or support ware during the firing operations.

burning tool mark, *n*—a defect in the porcelain enamel appearing on the surface opposite to the point of contact with the supporting burning tool.

button test, *n*—a test designed to determine relative fusibility of porcelain enamel frit or powder and so called because the completed specimens resemble buttons.

NOTE 6—See **flow button** and Test Methods C374.

cast iron enamel, *n*—a porcelain enamel specifically designed for application to cast iron.

ceramic coating, *n*—an inorganic, essentially nonmetallic coating, on metal that is a product of sintering and fusion of glass or ceramic materials, or both, applied by wet spray,

crossbend test, *n*—a test in which fired or bisque porcelain enamel panels are progressively distorted by bending to determine the resistance of the coating to cracking.

cup gun, *n*—a spray gun with a fluid container as an integral part.

cupping, *v*—the pouring of slip over areas of a part during draining to produce uniform application.

curling, *n*—a defect similar to crawling.

curtains, *n*—a defect in sheet steel ground coatings characterized by a draped pattern of darkened areas that are sometimes blistered. May also appear in cover coats applied over the ground coat or direct-on.

decarburized enameling steel, *n*—a special type of steel sheet of extremely low carbon content below 0.008 % achieved by open coil annealing (see Specification **A424** Type I).

decarburized steel, *n*—see **decarburized enameling steel**.

decking, *v*—the multiple layer loading of ware for firing.

de-enameling, *v*—the removal of porcelain enamel from the base metal.

deflocculating, *v*—the thinning of the consistency of a slip by adding a suitable electrolyte.

delayed fishscaling, *n*—a fishscaling defect that occurs after the final porcelain enamel processing (see also **fishscaling**).

devitrification, *n*—a surface defect manifested by loss of gloss as a result of crystallization.

dimple, *n*—a shallow depression in the porcelain enamel, sometimes a defect.

dipping, *v*—the process of coating a metal shape by immersion in slip, removal, and draining. In dry process enameling, the method of coating by immersing the heated metal shape for a short time in powdered frit.

dipping weight, *n*—see **pick-up**.

direct fire, *n*—a method of maturing porcelain enamel wherein the products of combustion come in contact with the ware.

direct-on, *n*—a single coat of enamel on the metal substrate.

double draining, *n*—a defect evidenced by flowing of the slip on the ware, which occurs after it appears that draining has been completed.

double-face ware, *n*—ware that has a finish coat on both surfaces.

draining, *v*—the part of the dipping or flowcoating process in which the excess slip flows from suitably positioned ware.

drain line, *n*—a nonuniform thickness of coating appearing as a line or streak in dipped or flow-coated ware.

drain time, *n*—time required for porcelain enamel slip applied by dipping, slushing, or flow coating to complete movement across the surfaces of a coated part.

dredge, dredging, *v*—*in dry process enameling*, (1) the application of dry, powdered frit to hot ware by sifting.

(2) The sieve used to apply powdered porcelain enamel frit to the ware.

drying crack, *n*—a defect characterized by a fissure in the bisque.

dry milling, *v*—the grinding of porcelain enamel materials without a liquid vehicle.

dry process enameling, *v*—a porcelain enameling process in which the metal article is heated to a temperature above the maturing temperature of the coating (usually 1600 to 1750 °F, (approximately 870 to 955 °C)), the coating materials applied to the hot metal as a dry powder, and fired.

dry spray, *n*—a defect confined to sprayed ware manifesting itself in the fired porcelain enamel as a rough, sandy texture.

dry weight, *n*—the weight per unit area of the bisque.

dust coat, *n*—a relatively thin, sprayed coating of slip.

dusting, *v*—(1) *in dry-process enameling*, see **dredging**.

(2) A spraying defect characterized by a piling up of almost dry slip in confined areas.

(3) The removal of extraneous material from the bisque before firing.

(4) See **dry spray**.

edging, *v*—(1) the process of removing bisque from the edge of a piece of ware to expose the underlying porcelain enamel.

(2) The spraying of special slip onto the edge of the ware.

edging brush, *n*—a stiff-bristled brush with metal guide, used to remove bisque from edges of ware before the firing operation.

eggshell or eggshelling, *n*—the texture of a fired ceramic coating similar in appearance to the surface of an eggshell. In porcelain enamel, usually a defect.

ejector air, *n*—air used to convey powder from pump to the part being coated.

electrophoretic deposition, *v*—the process of depositing material on a workpiece from a porcelain enamel slip suspension due to the movement of particles under the influence of an impressed direct current voltage.

electrostatic powder porcelain enamel, *n*—a mixture comprised of frit and additives ground or blended together, or both, to form a powder suitable for dry electrostatic application.

electrostatic retention, *n*—the tenacity with which a charged, electrostatically deposited powder porcelain coating adheres to the work piece before it is fired.

enamel, *n*—see **porcelain enamel**.

enamel, aluminum, *n*—see **aluminum enamel**.

enamel, beading, *n*—see **beading enamel**.

enamel, blackboard, *n*—see **chalkboard enamel**.

enamel, cast iron, *n*—see **cast iron enamel**.

enamel, chalkboard, *n*—see **chalkboard enamel**.

enamel, copper, *n*—see **copper enamel**.

enamel, jewelers', *n*—see **jewelers' enamel**.

enamel, reclaim, *n*—see **reclaim**.

enamel scrapings, *n*—see **scrapings**.

enameling iron, *n*—a very low-carbon, low-metalloid, cold-rolled sheet steel, produced specifically for use as a base metal for porcelain enamel.

etched, *adj*—an altered surface texture resulting from chemical attack.

fall-off, *n*—tendency of an electrostatically deposited powder to fall off the work piece during normal processing.

filter, *n*—see **plugging compound**.

film strength, *n*—the relative resistance of the bisque to mechanical damage.

fineness of enamel, *n*—a measurement of the degree to which a frit has been milled in wet or dry form, usually expressed in grams residue retained on a certain mesh screen from a 50 cm³ or a 100 g sample.

fire marks, *n*—a defect characterized by tiny indentations similar in appearance to shallow pinholes.

firing, *v*—the controlled heat treatment of ceramic ware in a kiln or furnace to develop the desired final properties.

firing range, *n*—the time-temperature interval in which a porcelain enamel or ceramic coating is satisfactorily matured.

firing temperature, *n*—the degree of sensible heat attained by the ware during the maturing of the coating.

firing time, *n*—the period during which the ware remains in the firing zone of the furnace to mature the coating.

firing zone, *n*—that portion of the furnace, usually a continuous furnace, through which the ware passes and that remains at or near the firing temperature of the coating.

first point of no break, *n*—the amount (weight-mass) of porcelain enamel slip retained when it stops sliding off an enameled pick-up panel and is observed to drain smoothly from the panel without showing a wavy pattern on the wet surface (known also as “yield point”).

fishscaling, *n*—a defect appearing as small half-moon shaped fractures somewhat resembling the scales of a fish.

fishscaling, delayed, *n*—see **delayed fishscaling**.

flaw, *n*—*in dry process enameling*, a defect of the ware that is cause for rejection.

fleck/mottle/speckle, *n*—see **speckled ware**.

flocculating, *v*—the thickening of the consistency of a slip by adding a suitable electrolyte.

flow-button, *n*—the pellet of frit used in the Fusion Flow Test.

NOTE 10—See Test Methods C374.

flow coating, *v*—the process of coating a metal shape by causing the slip to flow over its surface and allowing it to drain.

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

fork, *n*—a piece of metal equipment used during the firing operation for placing ware in, and removing it from a box furnace.

frit, clear, *n*—see **clear frit**.

frit, colored, *n*—see **colored frit**.

frit, porcelain enamel, *n*—the small friable particles produced by quenching a molten glassy material (see also **clear frit** and **colored frit**).

fritting, *v*—the rapid chilling of the molten glassy material to produce frit.

furnace, box, *n*—see **box furnace**.

furnace, continuous, *n*—see **continuous furnace**.

fusion flow, *n*—the relative flow of various glasses or frits in the molten state.

NOTE 11—See Test Methods C374.

fusion test, button, *n*—see **button test**.

fuzzy texture, *n*—a defect characterized by a myriad of minute bubbles, broken bubbles, and dimples in the porcelain enamel surface.

gassing, *v*—(1) the formation of gas bubbles due to bacterial contamination in the milled porcelain enamel slip.

(2) See **boiling**.

gassy surface, *n*—a defect characterized by poor gloss and fuzzy surface texture.

glass, *n*—a term sometimes used for porcelain enamel or frit.

glass-coated steel, glass-lined steel, glassed steel, *n*—designations generally applied to a class of porcelain enamels that have high resistance to chemical attack at elevated temperatures and pressures.

glass eye, *n*—a defect consisting of a large unbroken blister.

gloss, *n*—the shine or luster of a porcelain enamel; see Test Method D523.

NOTE 12—See Test Method C346.

graining, *v*—a process for producing a decorative finish by transferring a pattern to the porcelain enamel surface by means of rolls.

graining paste, *n*—a mixture of color oxides, fluxes, and oils.

graining roll, *n*—a specialized type of roll used for transferring the grain pattern to the porcelain enamel.

graniteware, *n*—a ground coated steel cookware with prominent white mottle/fleck.

ground coat, *n*—(1) a porcelain enamel applied directly to the base metal to function as an intermediate layer between the metal and the cover coat.