Designation: B846 – 19a

Standard Terminology for Copper and Copper Alloys[1]

This standard is issued under the fixed designation B846; 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 The terms defined in this terminology standard are applicable to copper and copper alloy products specifications, test methods, practices, and other documents within the jurisdiction of Committee B05 on Copper and Copper Alloys.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B153 Test Method for Expansion (Pin Test) of Copper and Copper-Alloy Pipe and Tubing

B170 Specification for Oxygen-Free Electrolytic Copper—Refinery Shapes

B379 Specification for Phosphorized Coppers—Refinery Shapes

E8/E8M Test Methods for Tension Testing of Metallic Materials

E10 Test Method for Brinell Hardness of Metallic Materials

E18 Test Methods for Rockwell Hardness of Metallic Materials

E23 Test Methods for Notched Bar Impact Testing of Metallic Materials

E112 Test Methods for Determining Average Grain Size

3. Significance and Use

3.1 This terminology is not intended to apply to any standard, test method, practice, or other document not within the jurisdiction of Committee B05 on Copper and Copper Alloys.

4. Terminology

acid dip—see **dip solution**.

acid dipped-dry rolled finish—see **finish, acid dipped-dry rolled**.

Admiralty—an alloy containing nominally 71 % copper: 1 % tin and 28 % zinc, originally developed by the British Admiralty and generally available in tube, flat products, and wire. Its principal use is in heat exchanger and condenser tubes. An inhibitor may be added to increase the resistance to dezincification.

Admiralty, inhibited (arsenical, antimonial or phosphorized)—admiralty modified by the addition of small amounts of arsenic, antimony or phosphorus to inhibit dezincification. (Copper Alloy Nos. C44300, C44400, C44500)

air stain—see **stain, air**.

alpha—the name of a phase or of a certain range of copper alloys which contain one or more alloying elements dissolved in copper, the phase being a homogeneous solid solution.

alpha beta brass—a series of copper-zinc alloys containing approximately 55 to 63 % copper and the remainder mostly, if not all, zinc and composed of crystals or grains of both the alpha and the beta phases.

aluminum brass—a copper alloy containing nominally 77.5 % copper, 2 % aluminum and 20.5 % zinc with an arsenical inhibitor, available in tube form. Its principal use is in heat exchanger and condenser tubes. (Copper Alloy No. C68700)

aluminum bronze—copper alloys with aluminum as the principal alloying element, normally in the range of 3 to 11 % with or without the additions of other elements. (Copper Alloy Nos. C60800 – 64699 incl.)

[1] This terminology is under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.93 on Terminology.

Current edition approved Aug. 1, 2019. Published August 2019. Originally approved in 1993. Last previous edition approved in 2019 as B846–19. DOI: 10.1520/B0846–19A.

[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.

***A Summary of Changes section appears at the end of this standard**

anneal (annealing)—a thermal treatment to change the properties or grain structure of the product. When applied to a cold-worked product having a single phase: to produce softening by recrystallization or recrystallization and grain growth, with the accompanying changes in properties. When applied to a product having two or more phases: to produce softening by changes in the phase relationship that may include recrystallization and grain growth.

annealability of copper rod—the ease with which a material will soften after cold work and subsequent thermal treatments; this property is affected primarily by the purity of the metal since all other variables are kept constant.

annular ring—see **circular ring**.

antimicrobial copper alloy—a solid wrought or cast copper alloy that is listed under one of the following U.S. Environmental Protection Agency (EPA) registration numbers: 82012-1, 82012-2, 82012-3, 82012-4, 82012-5, or 82012-6, or is otherwise identified by a Unified Numbering System copper alloy code in an active EPA public health registration.

arbor—a cylindrical core around which metal is wound to obtain a desired inside diameter of the wound coil or roll.

arc welding—a group of welding processes wherein coalescence is produced by heating with an arc or arcs, with or without the application of pressure, and with or without the use of filler metal.

architectural bronze—an alloy containing nominally 57 % copper, 3 % lead, and 40 % zinc, generally available in extruded or drawn shapes and rod; used for architectural trim and for some mechanical applications. The alloy is not technically a bronze, but because of long usage, the term "Architectural Bronze" has been used. (Copper Alloy No. C38500)

area reduction—the decrease in cross-section of a product by rolling or drawing, which is a measure of the temper of the metal in the cold worked condition.

argentiferous copper—see **silver bearing copper**.

arsenical tough pitch copper—a modified tough pitch copper containing substantial amounts of arsenic regardless of origin or treatment.

as-welded condition—a condition created as a result of forming annealed sheet or plate into tubular form and welding without subsequent heat treatment or cold work.

average diameter—the average of the maximum and minimum measured diameters at any one cross-section. This definition is the same for Average Outside Diameter or Average Inside Diameter, as long as the calculation is made with I.D. only or O.D. only measurements but not mixed (see Fig. 1).

average diameter (for round tubes only)—the average of the maximum and minimum outside diameters or the maximum and minimum inside diameters, whichever is applicable, as determined at any one cross section of the tube.

bar—a solid rectangular section, or one with two plane parallel surfaces and round or other simple regularly shaped edges, up to and including 12 in. (300 mm) in width and over 0.188 in. (5 mm) in thickness, furnished in straight lengths or in rolls and with finished edges, either rolled, drawn, or extruded.

bar, bus stock—high-conductivity copper bar stock of any dimension intended for use as an electrical conductor.

bar, cast—a flat casting for rolling into sheet and strip, or round casting for rolling and drawing into wire.

bar, cold-rolled—see **cold-rolled bar**.

bar, commutator segment stock—a bar for use in making commutators of electric motors and generators, the cross-section of the bar being a trapezoid or truncated sector or segment of a circle.

bar, drawn—see **drawn bar**.

bar, extruded—see **extruded bar**.

bar, hot-rolled—see **hot-rolled bar**.

barrel rolling—a method of polishing small parts in which the parts and a polishing medium are placed in a barrel, the polishing action resulting from the revolving of the barrel.

base metal—the sheet or plate from which the pipe is formed.

bend test—see **test, bend**.

beryllium copper—see **copper-beryllium alloy**.

billet—refinery shape used for piercing or extrusion into tubular products or for extrusion into rods, bars, and shapes. Circular in cross section, usually 3 to 16 in. (76 to 406 mm) in diameter, normally ranging in weight from 100 to 4200 lb (45 to 1905 kg).

bimetal tube—see **tube, bimetal**.

blank—a piece of flat product intended for subsequent fabrication by forming, bending, cupping, drawing, hot pressing, and so forth.

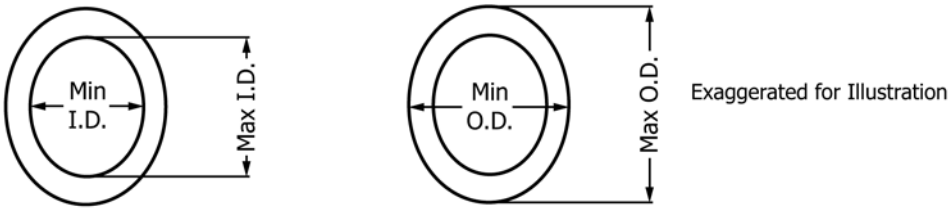


FIG. 1 Average Diameter

blanking—the process of cutting metal blanks by a die and punch set in a press, or by sawing or shearing.

*Bourdon gauge tube—*see **tube, Bourdon gauge**.

brass—any copper alloy with zinc as the principal alloying element, with or without small quantities of some other elements.

*brazed tube—*see **tube, brazed**.

brazing filler material—wire, rod, strip, or powder that is manufactured to special chemical composition for use in joining metals by brazing.

bridge plate—a low-friction plate of a copper alloy used to provide a bearing surface for the expansion end of trussed bridge structures.

*bright annealed finish—*see **finish, bright annealed**.

*bright dip—*see **dip, bright**.

*bright dipped finish—*see **finish, bright dipped**.

*bright rolled finish—*see **finish, dry rolled**.

*Brinell hardness test—*see **test, Brinell hardness**.

*brush brass finish—*see **finish, brush brass**.

buckle—alternate bulges and hollows recurring along the length of a flat product with the edges remaining relatively flat.

buckle (centre bulge or oil can)—alternate bulges and hollows recurring along the length of a strip with the edges remaining relatively flat.

*buffed surface finish—*see **finish, buffed surface.**

bulging—the expanding of a portion of the body of a drawn shell below the top or neck.

bull ring rod—copper rod manufactured to special surface requirements and furnished in coils for redrawing or rerolling.

*bull rod—*see **redraw rod**.

bursting pressure—the internal pressure required to burst tubes or other hollow products.

bus bar—includes material of solid rectangular or square cross section or a solid section with two plane parallel surfaces and round or other simple regular-shaped edges.

bus conductor stock—a bar, rod, shape or tube of high conductivity copper used for the manufacture of bus conductor or bus bar.

*bus stock bar—*see **bar, bus stock**.

*butt seam tube—*see **tube, open seam**.

cake—refinery shape used for rolling into plate, sheet, strip, or shape. Rectangular in cross section and of various sizes, normally ranging in weight from 140 to 62 000 lb (63 to 28 123 kg).

*camber—*see **edgewise curvature**.

capable of—the test need not be performed by the producer of the material. However, if subsequent testing by the purchaser establishes that the material does not meet the specified requirements, the material shall be subject to rejection.

capacitor plate stock—strip manufactured to special flatness and thickness tolerances for use in electrical variable capacitors.

cartridge brass—a copper alloy containing nominally 70 % copper and 30 % zinc and generally available in flat products, rod, wire, and tube. (Copper Alloy No. C26000)

*cast bar—*see **bar, cast**.

cast shell process—a process for making seamless tube whereby the metal is cast in the form of a shell or tube and subsequently reduced to the finished size by a series of suitable alternate cold drawing and annealing operations.

casting—a general term for a metal object produced at or near-finished shape by pouring or otherwise introducing molten metal into a mold and allowing it to solidify.

casting, centrifugal—a casting produced in a cylindrical mold rotating on its axis with the major axis of the product coinciding with the axis of rotation. The axis of rotation may be horizontal, vertical, or any angle in between.

casting, centrifuged—a casting produced in a mold, a number of which may be mounted around a central sprue. The molds are rotated, in a vertical position, about a central axis concentric with the central sprue.

casting, continuous—a casting produced by the continuous pouring and solidification of molten metal through a water-cooled mold which determines the cross-sectional shape. The length of the product is not restricted by mold dimensions.

casting, permanent mold—a product produced in a reusable mold constructed of a durable material, usually iron or steel, with the molten metal being introduced by gravity, low-pressure, or vacuum.

casting, sand—a casting produced in a sand mold.

casting, semicentrifugal—a casting produced in a manner similar to the centrifugal casting except that a central core is used to allow the formation of other than a cylindrical inside surface. The axis of rotation is always vertical.

cathode—unmelted, electrodeposited, and somewhat rough flat plate normally used for melting. The customary size is about 3 ft (0.914 m) square, about ½ to ⅞ in. (12.7 to 22.2 mm) thick, weighing up to about 300 lb (136 kg) and may have hanging loops attached. Cathodes may also be cut to smaller dimensions.

*cavitation corrosion—*see **corrosion, cavitation**.

chemically refined copper—copper recovered from an aqueous solution by other than electrolytic means. Usually when this term is used alone it refers to chemically refined tough

pitch copper. This designation applies to the following: (*a*) copper cast in refinery shapes suitable for hot or cold working, or both, and by extension, to fabricators products made therefrom, (*b*) ingots or ingot bars suitable for remelting.

circle—a completely round, commercially flat, solid blank made from a rolled product.

circular ring—a completely round, commercial flat blank lacking the central concentric area.

cladding ratio—ratio by percent thickness of the component layers, for example.

clean annealed finish—see **finish, clean annealed**.

clock brass—a term sometimes used to designate high-leaded brass. (Copper Alloy No. C34200)

close nipple—a nipple with no shoulder or unthreaded portion between two threads; the shortest possible pipe nipple with complete threads.

coalesced copper—a commercially pure oxygen-free copper formed in a protective atmosphere at elevated temperature but below its melting point by application of mechanical pressure to particles of electrolytic cathode copper. (Copper No. C10200)

coil—a length of the product wound into a series of connected turns. The unqualified term "coil" as applied to tube usually refers to a bunched coil.

coil, bunched—a coil in which the turns are bunched and held together such that the cross section of the bunched turns is approximately circular.

coil, double layer flat—a coil in which the product is spirally wound into two connected disc-like layers such that one layer is on top of the other. (Sometimes called "double layer pancake coil" or "double layer spirally wound coil.")

coil, helical—See **coil, level or traverse wound**.

coil, level or traverse wound—a coil in which the turns are wound into layers parallel to the axis of the coil such that successive turns in a given layer are next to one another. (Sometimes called a "helical coil.")

coil, level or traverse wound on a reel or spool—a coil in which the turns are positioned into layers on a reel or spool parallel to the axis of the reel or spool such that successive turns in a given layer are next to one another.

coil set—*as applied to strip*, the natural curvature remaining in strip after it has been unwound from a coil.

coil, single layer flat—a coil in which the product is spirally wound into a single disc-like layer. (Sometimes called "pancake coil" or "single layer spirally wound coil.")

coil, stagger wound—a coil in which the turns are positioned into layers approximately parallel to the axis of the coil, but not necessarily with the fixed regularity of a level or traverse wound coil.

cold heading—see **heading**.

cold-rolled bar—bar stock brought to final dimensions by cold rolling, regardless of prior operations.

cold-rolled finish—see **finish, cold-rolled**.

cold-rolled rod—rod stock brought to final dimensions by cold rolling, regardless of prior operations.

cold-rolled shape—shape stock brought to final dimensions by cold rolling, regardless of prior operations.

cold-rolled wire—wire stock brought to final dimensions by cold rolling, regardless of prior operations.

cold rolling—see **rolling**.

cold shortness—the characteristic of metals that are brittle at temperatures below the recommended hot working temperature range.

cold shut—(*1*) a discontinuity that appears on the surface of cast metal as a result of two streams of liquid metal meeting and failing to unite. (*2*) on a forging, a portion of the surface that is separated by oxide from the main body of the metal.

cold side—*as applied to forging*, the temperature range below the optimum hot working temperature.

cold work—controlled mechanical operations for changing the form or cross section of a product and for producing a strain-hardened product at temperatures below the recrystallization temperature.

collapsing pressure—the external hydrostatic or pneumatic pressure required to collapse a tube or other hollow article.

collett brass—see **high-leaded brass**.

commercial bronze—a copper alloy containing nominally 90 % copper and 10 % zinc, generally available in flat products, wire, rod, and tube. The alloy is not technically a bronze, but because of long usage the term "commercial bronze" has been used. (Copper Alloy No. C22000)

commercially pure copper—metal for which the specified minimum copper content is not less than 99.88 %, silver being counted as copper.

commutator segment stock bar—see **bar, commutator segment stock**.

condenser tube plate—plate manufactured to special thickness tolerances and furnished in various contours as tube sheets or head plates for condensers and heat exchangers.

copper alloy—metal for which the specified minimum copper content is less than 99.3 % and not less than 40 % and having no other element specified in excess of the copper content: exception to this definition occurs in the case of copper-nickel-zinc alloys where zinc slightly exceeds the copper content in certain alloys which are commonly designated as copper alloys.

Copper Alloy UNS No.—In the Unified Numbering System, wrought copper alloys are designated as C16000 to C79999 and cast copper alloys are designated as C81300 to C99999.

copper-beryllium alloy—heat-treatable copper alloys containing varying amounts of beryllium and sometimes small amounts of cobalt, nickel, and chromium. It is capable of being formed readily when in the soft condition and heat treated to hardnesses approaching those of steel. (Copper Alloy Nos. C17000 – C17530 incl.)

copper drainage tube—see **tube, copper drainage (DWV).**

copper-iron alloy—copper alloys with iron as the principal alloying element with or without the addition of other elements. (Copper Alloy Nos. C19200 – C19810 incl.)

copper-nickel alloy—copper alloys composed of copper and nickel with nickel content up to 40 % and with small additions of elements such as iron and manganese. (Copper Alloy Nos. C70000 – C72950 incl.)

copper service tube—see **tube, copper service**.

Copper UNS No.—In the Unified Numbering System, wrought coppers are designated as C10000 to C15999 and cast coppers are designated as C80000 to C81199.

core brass—see **radiator core brass**.

cored forgings—forgings produced between closed dies, including cores.

corner radius on square or rectangular wire—any configuration on the corner between a chamfer and a full radius. The measurement of a corner radius is the distance from the blend point on one surface to the extension of the other surface.

corrosion, cavitation—the damage caused to a material by a moving liquid and associated with the formation and collapse of cavities in the liquid at the solid-liquid interface.

corrosion, impingement attack—a type of localized corrosion caused by the striking of a liquid over a period of time containing entrained gases, on a metal surface.

corrosion, stress—spontaneous failure of metals by cracking under combined action of corrosion and residual or applied stress.

cracking, intercrystalline—see **intercrystalline cracking**.

cracking, intergranular—see **intercrystalline cracking**.

creep test—see **test, creep**.

crimped copper—copper in sheets or strips having relatively small transverse corrugations applied subsequent to normal finishing operations to provide for expansion, to increase rigidity, or for ornamental purposes.

cross rolling—rolling at a 90° angle to the long dimension of the metal; usually done to increase width.

cup test—see **test, cup**.

deep drawing brass—see **cartridge brass** or **yellow brass**.

dents—depressions in the copper foil which do not significantly change the thickness of the copper foil.

deoxidized copper, high-residual phosphorus—copper deoxidized with phosphorus residual in amounts 0.015 to 0.040 %. The copper is not susceptible to hydrogen embrittlement, as determined in Specification B379. The copper is of relatively low-electrical conductivity due to the amount of phosphorus present.

NOTE 1—International Standards Organization specifications permit up to 0.050 % phosphorus.

deoxidized copper, low-residual phosphorus—copper deoxidized with phosphorus residual in amounts 0.004 to 0.012 %. The copper is not readily susceptible to hydrogen embrittlement, as determined in Specification B379. The copper in the annealed condition has a minimum conductivity of 90 % IACS.

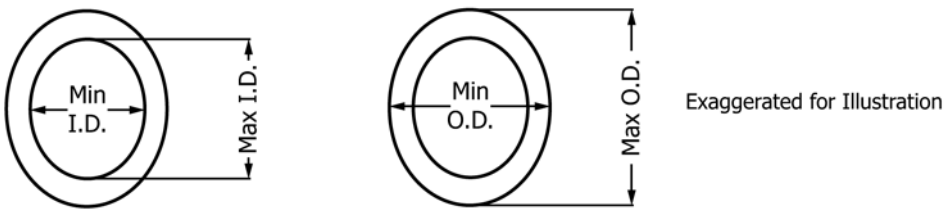
dewetting—a condition that results when molten solder has coated a surface and then receded leaving irregular-shaped mounds of solder separated by areas covered with a thin film but base metal is not exposed.

diameter at any point—inside or outside diameter can be measured at any point around the circumference of the tube. The individual readings may deviate from the nominal due to the tube being larger or smaller than nominal, or out of roundness, or a combination of the two (see Fig. 2).

die forgings—forgings produced between closed dies.

die scalping—drawing through a sharp-edged die to remove the surface layer.

die scratch—a longitudinal scratch on the surface of any drawn product resulting from the use of a roughened die or from the drag of a foreign particle between the die and the product.



Deviation of Actual Diameter at any Point = Max. Diameter – Nominal Diameter
Or, alternately = Nominal Diameter – Min. Diameter

FIG. 2 Diameter at any Point

die shaving—see **die scalping**.

dip, bright—a dip solution used to give a bright surface to copper alloys.

dip, matte—a dip solution used to obtain a matte or dull finish on copper alloys.

dip solution—any chemical solution used to produce a specific color or finish on copper or copper alloys.

disc—a round, commercially flat solid blank made from a flat rolled product.

disc straightening—see **straightening, ring or disc type**.

dish (cross or transverse bow)—the departure from flatness across the full width of the strip in the form of a single arc, excluding burrs.

disk—see **circle**.

distribution tube (Type D)—a seamless or welded copper tube known as copper distribution tube (Type D).

drainage tube—see **tube, copper drainage (DWV)**.

drawing brass—see **cartridge brass** or **yellow brass**.

drawn bar—bar stock brought to final dimensions by cold drawing through a die, regardless of temper or prior operations.

drawn finish—see **finish, drawn**.

drawn flat product—see **flat product, drawn**.

drawn rod—rod stock brought to final dimensions by cold drawing through a die, regardless of temper or prior operations.

drawn shape—shape stock brought to final dimensions by cold drawing through a die, regardless of temper or prior operations.

drawn stress relieved (DSR)—a thermal treatment of a cold-drawn tubular product to improve ductility without significantly affecting its tensile strength or microstructure.

drawn tube—tube stock brought to final dimensions by cold drawing through a die, regardless of temper or prior operations.

drawn wire—wire stock brought to final dimensions by cold drawing through a die, regardless of temper or prior operations.

drifting—the piercing of a hole and turning up a collar or flange, on sheet, strip, or articles made therefrom.

driving-band blank—see **rotating-band blank**.

dry rolled finish—see **finish, dry rolled**.

duplex tube—see **tube, bimetal**.

DWV tube—see **tube, copper drainage (DWV)**.

earing—a wavy projection in a regular geometric pattern on the rim of drawn cups formed in the course of deep drawing, as a result of directional properties or anisotropy of the sheet.

eccentricity—the difference between the maximum wall thickness and the minimum wall thickness determined at any one cross-section (see Fig. 3).

edge contours—see **finished edges**.

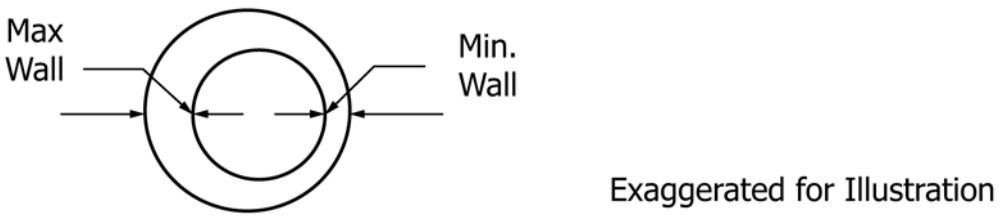
edgewise curvature—the lateral departure of the edge from a straight line, which may be unidirectional or reversing.

electrolytic copper—copper of any origin, refined by electrolytic deposition including electrowinning. Usually when this term is used alone it refers to electrolytic tough pitch copper. This designation applies to the following: (*a*) cathodes that are the direct product of the refining operation, (*b*) electrodeposited copper cast in refinery shapes suitable for hot or cold working or both, and by extension, to fabricators' products made therefrom, (*c*) electrodeposited copper cast into ingots or ingot bars suitable for remelting.

electrolytic tough pitch copper—a commercially pure high conductivity copper of any origin which has been produced by electrolytic deposition, then melted, oxidized, and brought to tough pitch or controlled low oxygen content, and finally cast into cakes, billets, wire bars, etc., suitable for hot or cold working, or both. (Copper No. C11000)

embossed tube—see **tube, embossed**.

embrittlement—the reduction of the normal ductility in a metal due to a physical or chemical change. As it relates to these test methods, embrittlement is the loss of ductility



Eccentricity = Max. Wall – Min. Wall
Percent Eccentricity = (Max. Wall – Min. Wall) / Average Wall × 100

NOTE 1—There are no tolerances established for Eccentricity in ASTM Tube and Pipe documents. This parameter is controlled through Wall Thickness at any Point Tolerances.

FIG. 3 Eccentricity