



Designation: **B 224 – 9804**

## Standard Classification of Coppers<sup>1</sup>

This standard is issued under the fixed designation B 224; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope\*

1.1 This is a classification of the various types of copper currently available in refinery shapes and wrought products in commercial quantities. It is not a specification for the various types of copper.

1.2 In this classification, use is made of the standard copper designations in use by the copper industry.

1.3 Although this classification includes certain UNS designations as described in Practice E 527, these designations are for cross-reference only and are not requirements. Therefore, in case of conflict, this ASTM classification shall govern.

1.4 This classification does not attempt to differentiate between all compositions that could be termed either coppers or copper-base alloys, but in conformance with general usage in the trade, includes those coppers in which the copper is specified as 99.85 % or more, silver being counted as copper.

NOTE 1—Coppers may contain small amounts of certain elements intentionally permitted to impart specific properties, without excessively lowering electrical conductivity. The total copper plus specific permitted elements is usually specified as 99.85 % or more. These intentionally permitted elements normally include, but are not limited to, arsenic, cadmium, chromium, lead, magnesium, silver, sulfur, tellurium, tin, zinc, and zirconium, plus deoxidizers, up to specific levels adopted by the International Standards Organization.

1.5 Units—The values stated in inch-pound units are to be regarded as ~~the~~ standard. The values given in parentheses are mathematical conversions to SI units, which are provided for information only and are not considered standard.

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<sup>1</sup> This classification is under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.07 on Refined Copper.

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

## 2. Referenced Documents

### 2.1 *ASTM Standards:*<sup>2</sup>

B 5 Specification for High Conductivity Tough Pitch Copper Refinery Shapes

B 30115 Specification for ~~Copper-Base Alloys in Ingot Form~~<sup>2</sup> Electrolytic Copper Cathode

B 14570 Specification for Oxygen-Free Electrolytic Cathode Copper<sup>2</sup> Copper—Refinery Shapes

B 21706 Specification for ~~Oxygen-Free Electrolytic Copper—Refinery Shapes~~<sup>2</sup> Tough-Pitch Fire-Refined Copper for Wrought Products and Alloys-Refinery Shapes

B 216379 Specification for ~~Tough-Pitch Fire-Refined Copper for Wrought Products and Alloys-Refinery Shapes~~<sup>2</sup>

B 379 Specification for Phosphorized Coppers—Refinery Shapes<sup>2</sup>

B 584 Specification for Copper Alloy Sand Castings for General Applications<sup>2</sup> Shapes

E 527 Practice for Numbering Metals and Alloys (UNS)

F 68 Specification for Oxygen-Free Copper in Wrought Forms for Electron Devices

## 3. Terminology

3.1 Appendix ~~X2~~ X1 describes the terms used in designating the various coppers listed.

3.2 Appendix ~~X3~~ X2 describes the refinery shapes.

3.3 Appendix ~~X4~~ X3 describes the fabricators' forms. ~~NOTE 2—Copper, as applied to castings other than refinery cast shapes, eakes, billets, wire bars, ingots, and ingot bars, is described in Specifications B 30 and B 584.~~

## 4. Significance and Use

4.1 This classification lists the types of copper available from refineries ~~and/or~~ or fabricators, or both, defines the common terms used, and gives the characteristics of many of the coppers available. It is useful to the neophyte looking for the appropriate copper for a particular application.

## 5. Basis of Classification

5.1 ~~Table X1.1 1~~ lists the standard designations, and the refinery shapes and fabricators' products currently produced. The listed coppers are not necessarily available in the complete range of sizes in the form shown, nor from any one supplier in all forms.

5.2 Existing ASTM specifications for refinery copper and for wrought copper products may cover more than one of the coppers listed in ~~Table X1.1 1~~ or may include only part of the range covered by any one of the coppers shown in this classification.

## 6. Keywords

6.1 classification, coppers

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards*, Vol 02.04, volume information, refer to the standard's Document Summary page on the ASTM website.

**TABLE 1 Classification of Coppers**

NOTE 1—Table 1 lists the standard designations, refinery shapes, and fabricator's products.

Designations	Type of Copper <sup>A</sup>	UNS Nos. <sup>B</sup>	Form in which Copper is Available <sup>C</sup>							
			From Refiners <sup>D</sup>			From Fabricators <sup>E</sup>				
			Wire Bars	Billets	Cakes	Ingots and Ingot Bars	Flat Products	Pipe and Tube	Rod and Wire	Shapes
<u>CATH</u>	<u>Electrolytic cathode</u>		<u>Cathodes only</u>							
			<u>Tough-Pitch Coppers</u>							
<u>ETP</u>	<u>Electrolytic tough-pitch</u>	<u>C11000</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>
<u>RHC</u>	<u>Remelted, high-conductivity tough pitch</u>	<u>C11010</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>
<u>ETP</u>	<u>Electrolytic tough-pitch (anneal resist)</u>	<u>C11100</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>
<u>FRHC</u>	<u>Fire-refined, high-conductivity tough-pitch</u>	<u>C11020</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>
<u>STP</u>	<u>Silver-bearing, tough-pitch</u>	<u>C11300,</u> <u>C11400,</u> <u>C11500,</u> <u>C11600</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>
<u>FRTSP</u>	<u>Fire-refined, tough-pitch</u>	<u>C12500</u>		<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>
<u>FRSTP</u>	<u>Fire-refined tough-pitch with silver</u>	<u>C12900</u>		<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>		<u>X</u>	<u>X</u>
			<u>Oxygen-Free Coppers (Without use of Deoxidants)</u>							
<u>OFE</u>	<u>Oxygen-free, electronic</u>	<u>C10100</u>	<u>X</u>	<u>X</u>	<u>X</u>		<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>
<u>OF</u>	<u>Oxygen-free</u>	<u>C10200</u>	<u>X</u>	<u>X</u>	<u>X</u>		<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>
<u>OFS</u>	<u>Oxygen-free, silver-bearing</u>	<u>C10400,</u> <u>C10500,</u> <u>C10700</u>	<u>X</u>	<u>X</u>	<u>X</u>		<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>
<u>OFXLP</u>	<u>Oxygen-free, extra low phosphorus</u>	<u>C10300</u>	<u>X</u>	<u>X</u>	<u>X</u>		<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>
<u>OFLP</u>	<u>Oxygen-free, low-phosphorus</u>	<u>C10800</u>	<u>X</u>	<u>X</u>	<u>X</u>		<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>
			<u>Deoxidized Coppers</u>							
<u>DLP</u>	<u>Phosphorized, low-residual phosphorus</u>	<u>C12000</u>		<u>X</u>			<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>
<u>DLPS<sup>F</sup></u>	<u>Phosphorized, low-residual phosphorus silver-bearing</u>	<u>C12100</u>		<u>X</u>			<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>
<u>DHP<sup>G</sup></u>	<u>Phosphorized, high-residual phosphorus</u>	<u>C12200</u>		<u>X</u>	<u>X</u>		<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>
<u>DHPS<sup>F</sup></u>	<u>Phosphorized, high-residual phosphorus silver-bearing</u>	<u>C12300</u>		<u>X</u>			<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>
<u>DPTE<sup>H</sup></u>	<u>Phosphorized, tellurium-bearing</u>	<u>C14520</u>		<u>X</u>					<u>X</u>	
			<u>Other Coppers</u>							
	<u>Sulfur-bearing</u>	<u>C14700</u>		<u>X</u>					<u>X</u>	
	<u>Zirconium-bearing</u>	<u>C15000</u>		<u>X</u>	<u>X</u>		<u>X</u>		<u>X</u>	
<u>PTE</u>	<u>Tellurium-bearing</u>	<u>C14500</u>		<u>X</u>					<u>X</u>	

<sup>A</sup> See Appendix X1.

<sup>B</sup> The chemical compositions associated with these numbers are listed in the product specifications and in the Standard Designations for Copper and Copper Alloys that appear in this publication under "Related Material".

<sup>C</sup> The "X" in the table indicates commercial availability.

<sup>D</sup> See Appendix X2.

<sup>E</sup> See Appendix X3.

<sup>F</sup> This includes oxygen-free copper to which phosphorus and silver have been added in amounts agreed upon.

<sup>G</sup> This includes oxygen-free copper to which phosphorus has been added.

<sup>H</sup> This includes oxygen-free tellurium-bearing copper to which phosphorus has been added in amounts agreed upon.

## APPENDIXES

### (Nonmandatory Information)

#### X1. CLASSIFICATION OF COPPERS

X1.1—Table X1.1 lists the standard designations, refinery shapes, and fabricator's products.

## ~~X2. TERMS~~

### X1. TERMS USED TO DESIGNATE THE COPPERS

(Alphabetical listing of these terms does not necessarily indicate relative order of commercial importance.)

#### **X21.1 Terms Relating to Method of Refining**

~~X2.1.1~~ *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:

~~X2.1.1.1~~ Ingots or ingot bars suitable for remelting.

~~X2.1.1.2~~

~~X1.1.1~~ *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:

~~X21.1.21.1~~ Cathodes that are the direct product of the refining operation as described in Specification B 115.

~~X21.1.21.2~~ Electrodeposited copper cast in refinery shapes suitable for hot or cold working or both, and by extension, to fabricators' products made therefrom.

~~X21.1.21.3~~ Electrodeposited copper cast into ingots or ingot bars suitable for remelting.

~~X21.1.32~~ *fire-refined copper*—copper of any origin or type finished by furnace refining without having been processed at any stage by electrolytic or chemical refining. Usually when the term fire-refined copper is used alone it refers to fire-refined tough pitch copper as described in Specification B 216. This designation applies to the following:

~~X21.1.32.1~~ Copper cast in refinery shapes suitable for hot or cold working or both, and by extension, to fabricators' products made therefrom.

~~X21.1.32.2~~ Ingots or ingot bars suitable for remelting.

#### **X21.2 Terms Relating to Characteristics Determined by Method of Casting or Processing**

~~X21.2.1~~ *deoxidized copper*—copper cast in the form of refinery shapes, produced free of cuprous oxide, as determined by metallographic examination at 75× under polarized light, by the use of metallic or metalloidal deoxidizers. Oxygen may be present as residual deoxidation products. By extension, the term applies to fabricators' products made therefrom.

~~X21.2.2~~ *oxygen-free copper*—electrolytic copper produced free of cuprous oxide, as determined by metallographic examination at 75× under polarized light, without the use of metallic or metalloidal deoxidizers. By extension, the term applies to fabricators' products made therefrom.

~~X21.2.3~~ *tough pitch copper*—copper of any origin cast in the form of refinery shapes, as described in Specification B 5, containing a controlled amount of oxygen in the form of cuprous oxide. By extension the term is also applicable to fabricators' products made therefrom.

#### **X21.3 Terms Relating to Specific Kinds of Copper and to Products Made Therefrom**

~~X21.3.1~~ *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 B 379. The copper is of relatively low-electrical conductivity due to the amount of phosphorus present.

NOTE ~~X21.1~~—International Standards Organization specifications permit up to 0.050 % phosphorus.

~~X21.3.2~~ *deoxidized copper, low-residual phosphorus*—copper deoxidized with phosphorous residual in amounts 0.004 to 0.012 %. The copper is not readily susceptible to hydrogen embrittlement, as determined in Specification B 379. The copper in the annealed condition has a minimum conductivity of 90 % IACS.

~~X21.3.3~~ *high-conductivity copper*—copper that in the annealed condition has a minimum electrical conductivity of 100 % IACS as required in Specifications B 5, B 115 and B 170.

~~X21.3.4~~ *oxygen-free electronic copper*—high-purity, high-conductivity oxygen-free copper normally intended for electronic and ultra-high vacuum (Specification F 68) applications. The copper has high resistance to hydrogen embrittlement, as determined in Specification B 170; or F 68, or both. The copper in the annealed condition has a minimum electrical conductivity of 101 % IACS.

~~X21.3.5~~ *oxygen-free copper, extra low phosphorus*—oxygen-free copper containing 0.001 to 0.005 % phosphorus. The copper is not readily susceptible to hydrogen embrittlement, as determined in Specification B 379. The copper in the annealed condition has a minimum conductivity of 98.16 % IACS.

~~X21.3.6~~ *oxygen-free copper, low phosphorus*—oxygen-free copper containing 0.005 to 0.012 % phosphorus. The copper is not susceptible to hydrogen embrittlement, as determined in Specification B 379. The copper in the annealed condition has a minimum conductivity of 90 % IACS.

- X21.3.7 *silver-bearing copper.*
- X21.3.8 *sulfur-bearing copper.*
- X21.3.9 *deoxidized, phosphorus-tellurium copper.*
- X21.3.10 *zirconium-bearing copper.*
- X21.3.11 *tellurium-bearing copper.*

NOTE X21.2—Coppers listed in X21.3.7-X21.3.11 contain the designated element or elements in amounts as agreed upon between the manufacturer or supplier and the purchaser.

### **X32. DEFINITIONS OF REFINERY SHAPES**

X32.1 *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).

X32.2 *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 28 200 kg).

X32.3 *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.

X32.4 *ingot and ingot bar*—refinery shapes used for remelting (not fabrication). Ingots normally range in weight from 20 to 35 lb (9 to 16 kg) and ingot bars from 50 to 70 lb (23 to 32 kg). Both are usually notched to facilitate breaking into smaller pieces.

X32.5 *wire bar*—refinery shape used for rolling into rod or flat product for subsequent processing into wire, strip, or shape. Approximately 3½ to 5 in. (89 to 127 mm) square in cross section, usually 54 in. (~~1.56 m~~) (1372 mm) in length and ranging in weight from 200 to 420 lb (91 to 191 kg). Usually tapered at both ends.

### **X43. DEFINITIONS OF FABRICATORS' COPPER PRODUCTS**

X43.1 *flat product*—a rectangular or square, solid section of relatively great length in proportion to thickness. Included in the designation “flat product” depending on the width and thickness, are plate, sheet, strip, and bar. Also included is the product known as “flat wire.”

X43.2 *pipe*—tube conforming to the particular dimensions commercially known as “Standard Pipe Sizes.”

X43.3 *rod*—a solid section, round, hexagonal, or octagonal in straight lengths. Round rod for further processing into wire (known as “hot-rolled rod,” “wire-rod,” “redraw wire,” or “drawing stock”) is furnished coiled.

X43.4 *shape*—a solid section, other than flat product, rod or wire, furnished in straight lengths. Shapes are usually made by extrusion but may also be fabricated by drawing.

X43.5 *tube*—a unidirectionally elongated hollow product of uniform round or other cross section having a continuous periphery.

X43.6 *wire*—a solid section, including rectangular flat wire but excluding other flat products, furnished in coils or on spools, reels, or bucks.



**SUMMARY OF CHANGES**

This section identifies

Committee B05 has identified the location of selected changes to B 224 this standard since 1996 issue: the last issue (B 224 – 98) that may impact the use of this standard. (Approved May 1, 2004.)

- ~~(1) Addition of Significance~~ Removed UNS Alloy Nos. C11030 (CRTP) and ~~Use section:~~ C12700, C12800, and C13000 (FRSTP) from the document.
- ~~(2) Expanded definition for OFE copper.~~ Removed terms describing “chemically refined copper” from the document.
- ~~(3) Removed Referenced Documents B 30 and B 584 from the document.~~
- ~~(4) Table X1.1 renamed as Table 1, former Appendix X1 removed and subsequent Appendixes renumbered.~~

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