Designation: B379 – 11

Standard Specification for Phosphorized Coppers—Refinery Shapes[1]

This standard is issued under the fixed designation B379; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification establishes the requirements for phosphorized copper wire bars, billets, and cakes.

NOTE 1—Wire bars furnished under this specification do not conform in dimensions with that furnished under Specification B5.

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

1.3 The following safety hazard caveat pertains only to the test method in sections 14.2 and 14.3 in this specification.

1.3.1 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B5 Specification for High Conductivity Tough-Pitch Copper Refinery Shapes

B193 Test Method for Resistivity of Electrical Conductor Materials

B224 Classification of Coppers

B577 Test Methods for Detection of Cuprous Oxide (Hydrogen Embrittlement Susceptibility) in Copper

B846 Terminology for Copper and Copper Alloys

E3 Guide for Preparation of Metallographic Specimens

E8 Test Methods for Tension Testing of Metallic Materials

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E53 Test Method for Determination of Copper in Unalloyed Copper by Gravimetry

E62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods) (Withdrawn 2010)[3]

E255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition

3. Terminology

3.1 For definitions of terms related to copper and copper alloys, refer to Terminology B846.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *copper, oxygen-free*—electrolytic copper produced without the use of metallic or metalloidal deoxidizers, free of cuprous oxide as determined by metallographic examination at 75× under polarized light.

4. Ordering Information

4.1 Contracts or purchase orders for product under this specification should include the following information:

4.1.1 ASTM designation and year of issue (for example, B379 – XX),

4.1.2 Copper UNS Number (for example, C10800),

4.1.3 Shape required: wire bar, billet or cake,

4.1.3.1 Billet end type,

4.1.4 Dimensions and tolerances (Section 10), and

4.1.5 Quantity; total weight or number of pieces for each shape, size,

4.2 The following are optional and should be specified in the contract or purchase order when required:

4.2.1 Hydrogen embrittlement test (Section 8),

4.2.2 Certification (Section 19), and

4.2.3 Test report (Section 20).

5. Materials and Manufacture

5.1 *Material:*

5.1.1 The product furnished shall be produced from one of the following coppers as specified in the contract or purchase order:

[1] This specification 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.

Current edition approved April 1, 2011. Published May 2011. Originally approved in 1962. Last previous edition approved in 2004 as B379 – 04. DOI: 10.1520/B0379-11.

[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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

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

TABLE 1 Chemical Requirements

Copper UNS No.	Type	Composition, %				
		Copper (Including Silver), min	Phosphorus		Arsenic	
			min	max	min	max
C10300	OFXLP	99.95[A]	0.001	0.005	. . .	. . .
C10800	OFLP	99.95[A]	0.005	0.012	. . .	. . .
C12000	DLP	99.90	0.004	0.012	. . .	. . .
C12200	DHP	99.9	0.015	0.040	. . .	. . .
C14200	DPA	99.4[B]	0.015	0.040	0.15	0.50

[A] Includes phosphorus.
[B] Copper (including phosphorus and arsenic) = 99.9 % min.

UNS Nos.	Former[4]	Description
C10300	OFXLP	Oxygen-free, extra low phosphorus
C10800	OFLP	Oxygen-free, low phosphorus
C12000	DLP	Phosphorus deoxidized, low residual phosphorus
C12200	DHP	Phosphorus deoxidized, high residual phosphorus
C14200	DPA	Phosphorus deoxidized, arsenical

5.2 *Manufacture:*

5.2.1 *Billets*—Unless specified otherwise, product up to and including 4 in. (102 mm) in diameter may be supplied sheared on one end with the other end flat. Billets over 4 in. in diameter shall be supplied with both ends flat. Billets shall not be cupped except by specific agreement between the manufacturer or supplier and the purchaser at the time of purchase and the agreement shall be part of the contract or purchase order.

6. Chemical Composition

6.1 The product material shall conform to the requirements prescribed in Table 1 for the specified copper.

6.1.1 These specification limits do not preclude the presence of other elements. Limits may be established and analysis required for unnamed elements by agreement between the manufacturer, or supplier, and the purchaser.

7. Physical Property Requirements

7.1 *Electrical Resistivity Requirement:*

7.1.1 The product furnished shall conform to the electrical mass resistivity requirement prescribed in Table 2, when tested in accordance with Test Method B193.

7.1.2 The maximum mass resistivity for Copper UNS Nos. C10800 and C12000, in the annealed condition, shall be 0.17081 ohm · g/m^2 (conductivity 90 %, minimum, International Annealed Copper Standard (IACS)) at 68°F (20°C).

8. Performance Requirements

8.1 *Reverse Bend Test (Hydrogen Embrittlement Susceptibility):*

8.1.1 When specified in the contract or purchase order, specimens of product produced of coppers UNS Nos. C10300, C10800, and C12000 shall be capable of withstanding a minimum of four bends without fracturing when tested in accordance with Test Method D of the current revision of Test Methods B577.

TABLE 2 Electrical Resistivity Requirements for UNS nos. C10300. C 10800, and C12000

Alloy	Electrical Resistivity max. Ω.g/m^2	Conductivity % IACS[A]
C10300	0.15614	98.16
C10800	0.17081	90
C12000	0.17081	90

[A] International Annealed Copper Standard.

9. Microscopical Examination

9.1 Coppers UNS Nos. C10300, C10800, and C12000 shall be essentially free of cuprous oxide as determined by examination in accordance with Test Method A of the current revision of Test Methods B577.

10. Dimensions, Mass, and Permissible Variations

10.1 *Wire Bars:*

10.1.1 The manufacturer or supplier should be consulted for dimensions and shapes available.

10.2 *Billets:*

10.2.1 A variation of ±5 % in weight and/or ±1⁄16 in. (±2 mm) in diameter from the manufacturer's published list or the purchaser's specified size shall be considered good delivery for billets up to 6 in. (152 mm) in diameter.

10.2.2 A variation of −1⁄8 in. (−3 mm) to +1⁄16 in. (+2 mm) in diameter and ±2 % in length shall be permitted for billets 6 in. (152 mm) and over in diameter.

10.2.3 Deviation from straightness shall not exceed 1⁄4 in. (6 mm) in 4 ft (1219 mm) as measured at the center of the billet.

10.2.4 Special diameter tolerances are subject to agreement between the manufacturer or supplier and the purchaser.

10.3 *Cakes:*

10.3.1 A variation up to 5 % in weight or 1⁄4 in. (6 mm) in any dimension shall be permitted for dimensions up to 8 in. (203 mm). A variation of 3 % in size shall be permitted for dimensions greater than 8 in. (203 mm).

11. Workmanship, Finish, and Appearance

11.1 The product shall be free from defects; but blemishes of a nature that do not interfere with the intended application are acceptable. The product shall be well cleaned and free from dirt.

[4] Refer to Table X1.1 of Classification B224 for former copper designations.

12. Sampling

12.1 The lot size, portion size, and selection of sample pieces shall be as follows:

12.1.1 *Lot Size*—An inspection lot shall consist of all pieces in a shipment produced during a single production period.

12.1.2 *Portion Size*— One piece shall be randomly selected from each 25 000 lb (11 340 kg) or fraction thereof.

12.2 *Chemical Composition:*

12.2.1 The sample for chemical analysis shall be taken in accordance with Practice E255 from the piece(s) selected in 12.1.2. The minimum weight of the composite sample shall be ⅓ lb (150 g).

12.2.2 Instead of sampling in accordance with Practice E255, the manufacturer shall have the option of determining composition from samples taken at the time the castings are poured or from samples taken from semifinished product. When the manufacturer determines chemical composition during the course of manufacture, sampling of the finished product by the manufacturer is not required. The number of samples to be taken for the determination of chemical composition shall be as follows:

12.2.2.1 When castings are poured, at least two samples shall be taken, one at the beginning of the pour and one at the end of the pour, for each group of castings poured from the same source of molten metal.

12.2.2.2 When taken from semi-finished product, at least two samples shall be taken, each from a different piece, to represent each 20 000 lb (9072 kg), or fraction thereof, except that not more than one sample shall be required per product piece.

12.3 *Samples for All Other Tests:*

12.3.1 Specimens for all other tests shall be taken from the sample portion selected in 12.1.2 and be of a convenient size to accommodate the tests.

13. Number of Tests and Retests

13.1 *Tests:*

13.1.1 *Chemical Analysis*—Chemical composition shall be determined as the per element mean of results from at least two replicate analyses of the sample(s).

13.1.2 *Other Tests:*

13.1.2.1 *Electrical Resistivity*—The individual test results from at least two specimens shall be reported.

13.1.2.2 *Hydrogen Embrittlement Test and Microscopical Examination*—At least two specimens shall be tested and each shall meet the requirements of the test.

13.2 *Retests:*

13.2.1 When requested by the manufacturer or supplier, a retest shall be permitted when test results obtained by the purchaser fail to conform with the requirement(s) of this specification.

13.2.2 Retesting shall be as directed in this specification for the specific property except the number of test specimens shall be twice that normally required for the test. Test results for all test specimens shall conform to the requirement(s) of this specification in retest and failure to comply shall be cause for lot rejection.

14. Specimen Preparation

14.1 *Chemical Analysis:*

14.1.1 Preparation of the analytical specimen shall be the responsibility of the reporting laboratory.

14.2 *Electrical Resistivity:*

14.2.1 The specimen shall conform to the requirements of the Test Specimens section of Test Method B193 and at least two specimens shall be prepared.

14.2.2 Each test specimen shall originate as a single piece or an appropriate size cut from a separate portion piece, when possible, selected in 12.1.2.

14.2.3 Alternatively, the manufacturer shall have the option of sampling the molten metal during the casting period by pouring at least two castings of suitable size.

14.2.3.1 The test specimens shall be forged or hot rolled. The external oxide shall be removed and the specimens cold drawn into a wire approximately 0.080 in. (2.03 mm) in diameter (12 gage AWG) and of a length adequate for the test. A specimen shall be cut from one end of each wire and be of a length sufficient to accommodate the testing equipment, annealed at approximately 932°F (500°C) for 30 min in an inert atmosphere, and rapidly cooled to ambient temperature without undue exposure to air.

14.3 *Hydrogen Embrittlement:*

14.3.1 The test specimens shall originate as a single piece cut from a portion piece selected in 12.1.2.

14.3.2 The test specimen shall be forged or hot rolled. The external oxide shall be removed and the specimen cold drawn into a wire approximately 0.080 in. (2.03 mm) in diameter (12 gage AWG) and of a length adequate for the test. Not less than two specimens shall be cut from one end of the wire and be of a length sufficient to accommodate the testing equipment.

14.3.2.1 Alternatively, test specimens may be taken from the unused portion of the unannealed wire prepared for the electrical resistivity test.

14.3.3 The test specimens shall be annealed in an atmosphere containing not less than 15 %, volume/volume, of hydrogen for 20 to 40 min in a furnace held at 1472 to 1607°F (800 to 875°C) and then rapidly cooled to ambient temperature without undue exposure to air.

14.4 *Microscopical Examination:*

14.4.1 Test specimen preparation shall be in accordance with Methods E3.

15. Test Methods

15.1 Test methods used for quality control or production control, or both, for the determination of conformance with product property requirements are discretionary.

15.1.1 Test methods used to obtain data for preparation of certification and test report shall be made available to the purchaser on request.

15.2 *Chemical Composition:*

15.2.1 Composition shall be determined, in case of disagreement, as follows:

Element	Method
Copper	E53
Phosphorus	E62
Arsenic	E62

15.2.2 Test method(s) to be followed for the determination of element(s) resulting from contractual or purchaser order agreement shall be as agreed upon between the manufacturer or supplier and the purchaser.

15.3 *Other Tests:*

15.3.1 The product furnished shall conform to physical property and other requirements when subjected to the appropriate test method in the following table:

Test	Methods
Electrical resistivity	B193
Microscopical examination	B577, Test Method A
Hydrogen embrittlement	B577, Test Method D

15.3.1.1 *Electrical Resistivity*—The limit of measurement uncertainty for Test Method B193 shall be ±0.30 % as a routine method and ±0.15 % as an umpire method.

16. Significance of Numerical Limits

16.1 For purposes of determining compliance with the specified limits for requirements of the properties listed in the following table, an observed value or calculated value shall be rounded as indicated in accordance with the rounding method of Practice E29.

Property	Rounded Unit for Observed or Calculated Value
Chemical composition	nearest unit in the last right-hand significant digit used in expressing the limiting value
Electrical resistivity	

17. Inspection

17.1 The manufacturer, or supplier, shall inspect and make tests necessary to verify that the furnished product conforms to specification requirements.

17.2 Source inspection of the product by the purchaser may be agreed upon between the manufacturer, or supplier, and the purchaser as part of the purchase order. In such case, the nature of the facilities needed to satisfy the inspector representing the purchaser that the product is being furnished in accordance with the product specification shall be included in the agreement. All testing and the inspection shall be conducted so as not to interfere unnecessarily with the operations of the works.

17.3 When mutually agreed upon, the manufacturer, or supplier, and the purchaser shall conduct the final inspection simultaneously.

18. Rejection and Rehearing

18.1 *Rejection:*

18.1.1 Product that fails to conform to the specification requirements when tested by the purchaser or purchaser's agent shall be subject to rejection.

18.1.2 Rejection shall be reported to the manufacturer, or supplier, promptly. In addition, a written notification of rejection shall follow.

18.1.3 In case of dissatisfaction with results of the test upon which rejection was based, the manufacturer or supplier shall have the option to make claim for a rehearing.

18.2 *Rehearing:*

18.2.1 As a result of product rejection, the manufacturer or supplier shall have the option to make claim for retest to be conducted by the manufacturer or supplier and the purchaser. Samples of the rejected product shall be taken in accordance with this product specification and subjected to test by both parties using the test method(s) specified in the product specification, or alternatively, upon agreement of both parties, an independent laboratory may be selected for the test(s) using the test method(s) specified in the product in the specification.

19. Certification

19.1 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been either tested or inspected as directed in this specification and the requirements have been met.

20. Test Report

20.1 When specified in the purchase order or contract, a report of the test results shall be furnished.

21. Product Identification

21.1 Each piece shall be marked with the producer's brand and lot identification number.

22. Packaging and Package Marking

22.1 *Packaging:*

22.1.1 The product shall be separated by shape, size, and copper and prepared for shipment by common carrier in such a manner to afford protection from normal hazards of transportation.

22.2 *Package Marking:*

22.2.1 Each shipping unit shall be legibly marked with the purchase order number, metal or alloy designation, size, shape, gross and net weight, and name of supplier. The specification number shall be shown when specified.

23. Keywords

23.1 oxygen-free; phosphorized copper billet; phosphorized copper cakes; phosphorized copper wire bar

SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue (B379 – 04) that may impact the use of this standard. (Approved April 1, 2011.)

(1) Scope section updated.
(2) Terminology section updated.
(3) Revision of 7.1.1.
(4) Revision to Section 17, Inspection.
(5) Revision to Section 18, Rejection and Rehearing.
(6) Revision to Section 21, Title.
(7) Revision to Section 22, Packaging and Package Marking.
(8) Addition of Table 2, Electrical Resistivity Requirements.