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Standard Specification for Materials for Copper Base Powder Metallurgy (PM) Structural Parts[1]

This standard is issued under the fixed designation B823; 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 covers a variety of copper base powder metallurgy (PM) structural materials, including those used in applications where high electrical conductivity is required. It includes a classification system, or material designation code. With the classification system, this specification includes chemical composition and minimum tensile yield strength.

NOTE 1—Paragraphs 6.1 and 8.1 govern material classification by the designation code. The classification system is explained in the Appendix.
NOTE 2—Materials classified as C-0000 are expected to be used in applications where high electrical conductivity is required.

1.2 *Units*—With the exception of density values, for which the gram per cubic centimetre (g/cm^3) unit is the industry standard, the values stated in inch-pound units are to be regarded as the standard. ~~Values in SI units result from conversion. They may be approximate and are for information only.~~ 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]
B243 Terminology of Powder Metallurgy
B925 Practices for Production and Preparation of Powder Metallurgy (PM) Test Specimens
B962 Test Methods for Density of Compacted or Sintered Powder Metallurgy (PM) Products Using Archimedes' Principle
B963 Test Methods for Oil Content, Oil-Impregnation Efficiency, and Surface-Connected Porosity of Sintered Powder Metallurgy (PM) Products Using Archimedes' Principle
E8 Test Methods for Tension Testing of Metallic Materials [Metric] E0008_E0008M
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
2.2 *MPIF Standard:*[3]
MPIF Standard 35, Materials Standards for PM Structural Parts

3. Terminology

3.1 *Definitions*—Definitions of powder metallurgy terms can be found in Terminology B243. Additional descriptive information is available ~~in the Related Materials section of Vol 02.05 of the~~under "General Information on PM Gray Pages" on the B09 ~~Annual Book of ASTM Standards.~~page of the ASTM website.

4. Ordering Information

4.1 Materials for parts covered by this specification shall be ordered by materials designation code.

4.2 Orders for parts under this specification may include the following information:
4.2.1 Certification, if required (see Section 13),

[1] This ~~test method~~ specification is under the jurisdiction of ASTM Committee B09 on Metal Powders and Metal Powder Products and is the direct responsibility of Subcommittee B09.05 on Structural Parts.
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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.
[3] Available from Metal Powder Industries Federation (MPIF), 105 College Rd. East, Princeton, NJ 08540, http://www.mpif.org.

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

4.2.2 Dimensions (see Section 9),
4.2.3 Chemical composition (see 6.1, 10.1, and Table 1),
4.2.4 Test methods and mechanical properties (see 8.2 , 8.3, Table 2, Table X1.1, and Table X1.2),
4.2.5 Density (see 7.1 and Table 3),
4.2.6 Porosity and oil content (see 7.3),
4.2.7 Electrical properties (see 7.3 and Table X2.1), and
4.2.8 Special packaging, if required.

5. Materials and Manufacture

5.1 Structural parts shall be made by compacting and sintering metal powders. Parts may also be made by repressing and resintering sintered parts, if necessary, to produce finished parts in conformance with the requirements of this specification.

6. Chemical Composition

6.1 The material shall conform to the requirements provided in Table 1.

6.2 Chemical analysis shall be performed in accordance with the methods prescribed in Vol 03.05 of the *Annual Book of ASTM Standards*, or by any other approved method agreed upon between the producer and the purchaser.

NOTE 3—Iron contamination should be avoided. Iron in solid solution in copper has a deleterious effect on both electrical and thermal conductivity. Iron not in solid solution (admixed) has a much lesser effect on conductivity. An example of the effect of iron on conductivity is shown in Fig. X2.1.

7. Physical Properties

7.1 *Density:*

7.1.1 *High Electrical Conductivity ~~Application:~~ Application*—In applications where high electrical conductivity is required, if the density does not vary more than 0.3 g/cm^3 from one section of the structural part to any other section, the overall density shall fall within the limits prescribed in Table 3. If the density varies more than 0.3 g/cm^3 from one section of the part to another, the

TABLE 1 Chemical Requirements

Material Designation	Chemical Composition, %[A,B] Cu	Zn	Pb	Sn	Ni	
C-0000	99.8					min
	100					max
CZ-1000	88.0	Bal.	. . .	. . .	. . .	min
	~~91.0~~	~~Bal.~~	~~. . .~~	~~. . .~~	~~. . .~~	~~max~~
	91.5	Bal.	. . .	. . .	. . .	max
~~CZP-1002~~	~~88.0~~	~~Bal.~~	~~1.0~~	~~. . .~~	~~. . .~~	~~min~~
CZP-1002	87.0	Bal.	1.0	. . .	. . .	min
	~~91.0~~	~~Bal.~~	~~2.0~~	~~. . .~~	~~. . .~~	~~max~~
	90.0	Bal.	2.0	. . .	. . .	max
~~CZ-2000~~	~~77.0~~	~~Bal.~~	~~. . .~~	~~. . .~~	~~. . .~~	~~min~~
CZ-2000	78.0	Bal.	. . .	. . .	. . .	min
	~~80.0~~	~~Bal.~~	~~. . .~~	~~. . .~~	~~. . .~~	~~max~~
	82.0	Bal.	. . .	. . .	. . .	max
CZP-2002	77.0	Bal.	1.0	. . .	. . .	min
	80.0	Bal.	2.0	. . .	. . .	max
~~CZ-3000~~	~~68.5~~	~~Bal.~~	~~. . .~~	~~. . .~~	~~. . .~~	~~min~~
CZ-3000	68.0	Bal.	. . .	. . .	. . .	min
	71.5	Bal.	. . .	. . .	. . .	max
~~CZP-3002~~	~~68.5~~	~~Bal.~~	~~1.0~~	~~. . .~~	~~. . .~~	~~min~~
CZP-3002	67.0	Bal.	1.0	. . .	. . .	min
	~~71.5~~	~~Bal.~~	~~2.0~~	~~. . .~~	~~. . .~~	~~max~~
	70.0	Bal.	2.0	. . .	. . .	max
CNZ-1818	62.5	Bal.	. . .	. . .	16.5	min
	65.5	Bal.	. . .	. . .	19.5	max
CNZP-1816	62.5	Bal.	1.0	. . .	16.5	min
	65.5	Bal.	2.0	. . .	19.5	max
CT-1000	87.5	. . .	. . .	9.5	. . .	min
	90.5	. . .	. . .	10.5	. . .	max

[A] Other elements: For the C-0000 material, the total by difference equals 0.2 % maximum; for all others, the total by difference equals 2.0% maximum; these may include other minor elements added for specific purposes.

[B] ~~For~~ For the purpose of determining conformance with this specification, measured values shall be rounded "to the nearest unit" in the last right-hand digit used in expressing the specification limit, in accordance with the rounding-off method of Practice E29

TABLE 2 Minimum Yield Strength for Copper Base Alloys

Material Designation Code	Minimum Yield Strength, 10^3 psi[A]
C-0000–5	5
C-0000–7	7
CZ-1000-9	9
-10	10
-11	11
CZP-1002-7	7
CZ-2000-11	11
-12	12
CZP-2002-11	11
-12	12
CZ-3000-14	14
-16	16
CZP-3002-13	13
-14	14
CNZ-1818-17	17
CNZP-1816-13	13
CT-1000-13 (repressed)	13

[A] ~~For~~ For the purpose of determining conformance with this specification, measured values shall be rounded "to the nearest unit" in the last right-hand digit used in expressing the specification limit, in accordance with the rounding-off method of Practice E29.

TABLE 3 Density Requirements for High Electrical Conductivity Applications

Material Designation Code	Sintered Density, g/cm^3[A]
C-0000–5	7.8 to 8.3
C-0000–7	8.3 min

[A] ~~For~~ For the purpose of determining conformance with this specification, measured values shall be rounded "to the nearest unit" in the last right-hand digit used in expressing the specification limit, in accordance with the rounding-off method of Practice E29.

producer and the purchaser shall agree upon a critical section of the part where the stresses are highest. The density of this critical section, rather than the average density, shall fall within the limits prescribed in Table 3.

7.1.2 *Other ~~Applications:~~ Applications*—The producer and the purchaser may agree upon a minimum average density for the part and minimum densities for specific regions of the part. Typical density values may be found in Table X1.1.

7.1.3 Density shall be determined in accordance with Test ~~Method~~Methods B962.

7.2 *Porosity:*

7.2.1 The producer and the purchaser may agree upon a minimum volume oil content for parts that are to be self-lubricating. The oil content shall be determined in accordance with Test Methods B963.

7.2.2 The producer and the purchaser may agree upon a functional test for porosity in parts that are to be self-lubricating, or for permeability where fluid flow must be restricted.

7.3 *Electrical Conductivity:*

7.3.1 The producer and the purchaser shall agree on qualification tests to determine the electrical conductivity. The test shall be made on sample parts or specimens compacted to a given density using an apparatus based on the eddy-current principle.

7.3.1.1 Conductivity is determined with an instrument that indicates the resistance of a material to the flow of eddy currents. Prior to making the tests, the instrument is allowed to warm up for a period of time recommended by the manufacturer. The instrument is adjusted using three standards of known conductivity supplied by the manufacturer. Test specimens shall be at the same temperature as the reference materials used in adjusting the instrument. Several readings at different locations are taken on each test specimen to obtain an average value.

7.3.1.2 No specimen preparation is required, providing the surface is flat in the probe area.

7.3.1.3 Electrical conductivity values shall be reported in percent IACS (International Annealed Copper Standards).

NOTE 4—Typical electrical conductivity values that may be expected from special specimens compacted to size are given in Table X2.1.

8. Mechanical Properties

8.1 The minimum guaranteed tensile yield strength, as shown in Table 2, is a numerical suffix to the material designation code and is read as 10^3 psi. The code is adopted from MPIF Standard 35. All tensile yield strengths are defined as the 0.2 % offset yield strengths.

8.2 The producer and purchaser shall agree upon the method to be used to verify the minimum strength characteristics of the finished parts. Since it is usually impossible to machine tensile test specimens from these parts, alternative strength tests are advisable. An example would be measuring the force needed to break teeth off a gear with the gear properly fixtured.

8.3 The tensile yield strength of the part may be measured indirectly by testing flat unmachined tension test specimens as specified in Practices B925, compacted from the same mixed powder lot at the density of the critical region of the parts and then processed along with the parts.

8.4 Transverse rupture strength values can also be related to tensile yield strengths by correlation. While many nonferrous PM materials are technically too ductile for this simple beam test, the test values are reproducible and useful.

8.5 Typical mechanical property values may be found in Table X1.1 and Table X1.2.

9. Permissible Variations in Dimension

9.1 Permissible variations in dimensions shall be within the limits specified on the drawings which describe the structural parts that accompany the order, or variations shall be within the limits specified in the order.

10. Sampling

10.1 *Chemical Analysis*—When requested on the purchase order, at least one sample for chemical analysis shall be taken from each lot. A sample of chips may be obtained by dry-milling, drilling, or crushing at least two pieces with clean dry tools without lubrication. In order to obtain oil-free chips, the parts selected for test shall have the oil extracted in accordance with Test Methods B963, if necessary.

10.2 *Mechanical Tests*—The producer and the purchaser shall agree upon a representative number of specimens for mechanical tests.

10.3 *Conductivity Tests*—At least two samples shall be taken from each lot for conductivity measurement, if required.

11. Inspection

11.1 Inspection of the material shall be agreed upon between the producer and purchaser as part of the purchase order or contract.

12. Rejection and Rehearing

12.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection should be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with test results, the producer or supplier may make claim for a rehearing.

13. Certification

13.1 When specified in the purchase order or contract, the purchaser shall be furnished certification stating samples representing each lot have been tested and inspected as indicated in this specification and the requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished. Test reports may be transmitted to the purchaser by electronic services. The content of the electronically transmitted document shall conform to any existing agreement between the producer and purchaser.

14. Keywords

14.1 brass; bronze; copper alloys; copper base; nickel silver; nonferrous powder metallurgy; nonferrous structural parts; powder metallurgy (PM); structural parts