Designation: B 715 – 96 (Reapproved 2001)

Standard Specification for Sintered Copper Structural Parts for Electrical Conductivity Applications[1]

This standard is issued under the fixed designation B 715; 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 sintered Powder Metal (P/M) structural parts of substantially pure copper of two types depending on density. It is anticipated that the parts will be used in applications where high electrical conductivity is required.

1.2 The values stated in inch-pound units are the standard. The SI values in parentheses are for information only and may be approximate.

2. Referenced Documents

2.1 *ASTM Standards:*

B 243 Terminology of Powder Metallurgy[2]

B 328 Test Method for Density, Oil Content, and Interconnected Porosity of Sintered Powder Metal Structural Parts and Oil-Impregnated Bearings[2]

E 8 Test Methods of Tension Testing of Metallic Materials[3]

3. Terminology

3.1 *Definitions*—Definitions of powder metallurgy terms can be found in Terminology B 243. Additional descriptive information is available in the Related Materials section of Vol 02.05 of the *Annual Book of ASTM Standards*.

4. Ordering Information

4.1 Orders for parts under this specification shall include the following information:

4.1.1 Dimensions (see Section 9),

4.1.2 Chemical composition (see 6.1 and Table 1),

4.1.3 Density (see 7.1 and Table 2),

4.1.4 Mechanical properties (see Section 8),

4.1.5 Electrical properties (see 7.2),

4.1.6 Certification (see Section 13), and

4.1.7 Metallography (see Section 14).

TABLE 1 Chemical Requirements

Element	Composition, %
Copper, min	99.80
Other, max	0.20

5. Materials and Manufacture

5.1 Structural parts shall be made by molding and sintering metal powders followed by repressing and resintering, if necessary, to produce finished parts conforming to the requirements of this specification.

6. Chemical Composition

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

6.2 The chemical analysis shall be made 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 manufacturer and the purchaser.

NOTE 1—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. X1.1 appended.

7. Physical Properties

7.1 *Density:*

7.1.1 The density shall be determined by Test Method B 328. 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 2. If the density varies more than 0.3 g/cm^3 from one section of the part to another, the manufacturer 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 2.

TABLE 2 Density Requirements

Type	Dry Density, g/cm^3
I	7.8 to 8.3
II	8.3 min

[1] This 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] *Annual Book of ASTM Standards*, Vol 02.05.

[3] *Annual Book of ASTM Standards*, Vol 03.01.

7.2 *Electrical Conductivity:*

7.2.1 The manufacturer and the purchaser shall agree on qualification tests to determine the electrical conductivity.[4] The test shall be made on sample parts or specimens molded to a given density using an apparatus based on the eddy-current principle.

7.2.1.1 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 must 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 a representative average value.

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

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

NOTE 2—Typical electrical conductivity values which may be expected from special specimens molded to size are given in Table X1.1.

8. Mechanical Properties

8.1 The manufacturer and the purchaser shall agree on both qualification tests and limits for the determination of mechanical properties. These tests shall be made on sample parts or specimens and should be determined after consideration of the function a part is to perform. Subsequent to the approval of the first sample parts on which the qualification tests have been set up, all parts in the shipment shall conform to the limits agreed upon.

NOTE 3—Typical properties in tension which may be expected from special specimens molded to size are given in Table X1.1.

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 *Lot*—Unless otherwise specified, a lot shall consist of parts of the same form and dimensions, made from powder of the same composition, molded and sintered under the same conditions, and submitted for inspection at one time.

10.2 *Chemical Analysis*—If required by purchase agreement, at least one sample for chemical analysis shall be taken from each lot. A representative 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 Method B 328, if necessary.

10.3 *Mechanical Tests*—The manufacturer and purchaser shall agree upon a representative number of specimens for mechanical tests.

10.4 At least two samples shall be taken for conductivity measurement from each lot.

11. Inspection

11.1 Unless otherwise specified, inspection of parts supplied on contract shall be made by the purchaser.

12. Rejection and Rehearing

12.1 Parts that fail 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, a producer's certification shall be furnished to the purchaser that the parts were manufactured, sampled, tested, and inspected in accordance with this specification and have been found to meet the requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

13.2 The purchase order must specify whether or not the certification includes chemistry.

13.3 Upon request of the purchaser in the contract or order, the certification of an independent third party indicating conformance to the requirements of this specification may be considered.

14. Supplementary Requirements

14.1 *Metallographic Examination*—When specified in the purchase order or contract, either or both of the following supplementary requirements may be applied. Details of these supplementary requirements shall be agreed upon in writing between the producer or supplier and purchaser. Supplementary requirements shall in no way negate any requirement of the specification itself.

14.1.1 *Sintering*—Requirements for uniformity and quality of sintering may be agreed upon.

14.1.2 *Porosity*—Requirements excluding excessively large pores may be included when specified and agreed upon in writing.

15. Keywords

15.1 conductive powder metallurgy; copper powder metallurgy; electrical parts; powder metallurgy; structural copper parts; thermally conductive parts

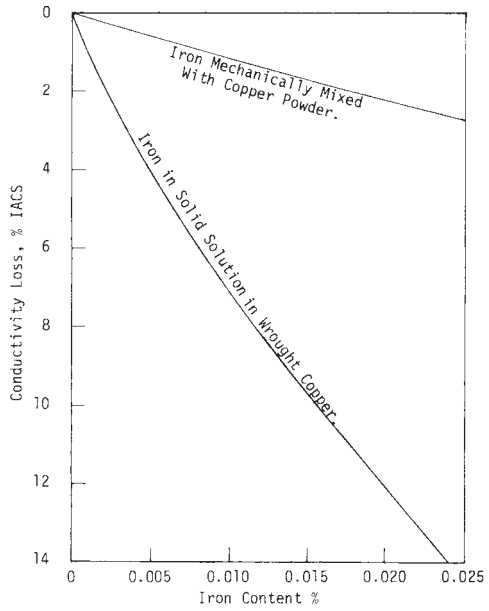
[4] Taubenblat, P. W., "Techniques for Measuring and Attaining High Electrical Conductivity with Copper Powder Compacts," *International Journal of Powder Metallurgy*, Vol 5, No. 2, April 1969, pp. 89–95.

APPENDIX

(Nonmandatory Information)

X1. TENSILE AND ELECTRICAL CONDUCTIVITY PROPERTIES

X1.1 Typical tensile and electrical conductivity properties of molded and sintered copper specimens are shown in Table X1.1. These data do not constitute a part of this specification.



NOTE 1—325 mesh iron powder admixed with copper powder, compacted at 20 tons per square inch (tsi) and sintered at 1000°C for 30 min in hydrogen.

FIG. X1.1 Electrical Conductivity Loss Resulting from Iron Contamination

TABLE X1.1 Typical Tensile Properties and Electrical Conductivity of Copper P/M Parts

NOTE 1—Properties depend on whether specimens are: (*a*) in the sintered condition only; (*b*) in the sintered and repressed condition; and (*c*) in the sintered, repressed, and resintered condition.

	Type I	Type II
Density, g/cm^3	8.0	8.3 min
Ultimate tensile strength, psi	23 000	28 000 min
Ultimate tensile strength, Mpa	159	193 min
Elongation, %	20	30 min
Electrical conductivity (grade 1), % IACS	85	90 min
Electrical conductivity (grade 1), S/m	0.493×10^8	0.522×10^8

They merely indicate to the purchaser the properties that may be expected from special tension specimens conforming to the specified density and chemical composition requirements. It should be thoroughly understood that the values represent specimens molded to size and not specimens cut from commercial parts or specimens machined from sample blanks. The tension tests are run on flat specimens approximately ¼ by ¼ in. in cross section with a gage length of 1 in. For specimen size and test details, refer to Test Methods E 8. The electrical conductivity may be measured on the finished part if it is at least ½ in. in diameter. See also Fig. X1.1.[5]

[5] Taubenblat, P. W., "Importance of Copper in Powder Metallurgy," *International Journal of Powder Metallurgy and Powder Technology*, Vol 10, No. 3, July 1974, pp. 169 - 184.