Designation: B663/B663M – 16

Standard Specification for Silver-Tungsten Carbide Electrical Contact Material[1]

This standard is issued under the fixed designation B663/B663M; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This specification covers electrical contact components made from silver-tungsten carbide materials by powder metallurgical processes.

1.2 This specification covers compositions within the silver-tungsten carbide system normally specified by users of contacts.

NOTE 1—Table X1.1 and Table X1.2 in Appendix X1 provide a list of typical compositions used for various applications.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.4 *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 become familiar with all hazards including those identified in the appropriate Safety Data Sheet (SDS) for this product/material as provided by the manufacturer, 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]

B328 Test Method for Density, Oil Content, and Interconnected Porosity of Sintered Metal Structural Parts and Oil-Impregnated Bearings (Withdrawn 2009)[3]

3. Significance and Use

3.1 Proprietary methods for the manufacture of these materials vary significantly among suppliers, and these methods influence such properties as arc erosion, contact resistance, and the tendency to weld in service. Since the performance of contacts in a device depends on numerous factors outside the contact itself (opening speed, closing speed, contact pressure, contact bounce, environmental variations, assembly technique and variations, etc.), this specification cannot ensure performance control in the application. As part of the qualification on initial samples, it is recommended that the user functionally and electrically test the materials for all devices applicable to the material's use. This specification will provide a means for the contact manufacturer and contact user to reach agreement on the details of the material to be supplied for a specific use, and reasonable assurance that future lots will be similar in properties and microstructure to the initial test or sample contacts supplied.

4. Ordering Information

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

4.1.1 Dimensions (see Section 10),

4.1.2 Chemical composition (see Table X1.1 and Table X1.2 in Appendix X1 as a guideline),

4.1.3 Physical properties (see Section 6 and Appendix X1 as a guideline),

4.1.4 Certification (see Section 13), and

4.1.5 Other features as agreed upon between the manufacturer and purchaser.

5. Chemical Composition

5.1 The material shall conform to composition limits as agreed upon between the manufacturer and the purchaser.

5.2 The chemical analysis shall be made in accordance with the methods prescribed in the newest edition of Volume 01.02 of the *Annual Book of ASTM Standards* or by any other approved method agreed upon between the manufacturer and the purchaser.

6. Physical Properties

6.1 The manufacturer and the purchaser shall agree on qualification tests for determination of physical properties.

[1] This specification is under the jurisdiction of ASTM Committee B02 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.05 on Precious Metals and Electrical Contact Materials.

Current edition approved May 1, 2016. Published May 2016. Originally approved in 1979. Last previous edition approved in 2012 as B663 – 94 (2012). DOI: 10.1520/B0663/B0663M-16.

[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.

6.2 The tests shall be performed on production parts, wherever practical or applicable. (Small size contacts do not lend themselves to accurate conductivity measurement.)

6.3 The tests shall be determined after consideration of the function of the part.

6.4 The typical properties of three most common types of silver-tungsten carbide contacts are given in Appendix X1.

7. Dimensions, Mass, and Permissible Variations

7.1 Permissible variations in dimensions shall be within the limits specified on drawings describing the contacts and accompanying the order, or shall be within the limits specified in the purchase order.

8. Finishing of Contacts

8.1 The material shall be finished by such operations as necessary to meet requirements agreed upon between the manufacturer and the purchaser of the contacts (braze alloy backing, tumbling to polish surfaces, special surface finish, silver-rich surface layer, cleaning, etc.).

9. Workmanship, Finish, and Appearance

9.1 The parts shall be free of defects in material or processing, that would seriously affect their performance.

10. Sampling

10.1 *Lot*—Unless otherwise specified, a lot shall consist of parts of the same form and dimensions, made of powders of the same particle size range and composition, processed under the same conditions, and submitted for inspection at the same time.

10.2 *Chemical Analysis*

10.2.1 At least one sample for chemical analysis shall be taken from each lot. A representative sample of chips may be obtained by milling, drilling, or crushing at least two pieces with 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 B328, if necessary.

10.2.2 These specification limits do not preclude the possible presence of other unnamed elements, impurities, or additives. Analysis shall be regularly made only for the minor elements listed in the table. However, if a user knows of elements that might be detrimental to their application or has other reasons for requiring analysis for specific elements, then agreement between manufacturer and purchaser for both limits and methods of analysis should be required for elements not specified.

10.3 *Physical Tests*—The manufacturer and the purchaser shall agree on a representative number of specimens for physical tests including microstructure.

11. Inspection

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

12. Rejection

12.1 Unless otherwise specified, rejections based on tests made in accordance with the specification shall be reported to the manufacturer within 30 days of the receipt of the shipment.

13. Certification

13.1 A certification, when requested by the user, based on the manufacturer's quality control that the material conforms to the requirements of this specification, shall be furnished upon request of the purchaser, provided the request is made at the time of cost quotation and at the time of order placement.

14. Keywords

14.1 arcing contacts; contacts; electrical contacts; powder metallurgy; silver; silver tungsten carbide; tungsten carbide; tungsten carbide silver

APPENDIX

(Nonmandatory Information)

X1. TYPICAL PROPERTY VALUES

X1.1 The following information provides guidelines for users and manufacturers of silver-tungsten carbide contact material. Typical ranges of chemistry and properties are given for the three most popular compositions, 40 % silver/60 % tungsten carbide, 50 % silver/50 % tungsten carbide, 65 % silver/35 % tungsten carbide. These properties are influenced by the particle size, shape, and distribution of tungsten carbide, homogeneity, impurities or additives, and other manufacturing process variables.

NOTE X1.1—Table X1.1 and Table X1.2 represent the major manufacturing techniques used in industry. The size and shape of the part is important in choosing the optimum technique as well as other considerations such as frequency of operation of the device, and how crucial is its application

X1.1.1 The best choice for a given application should be mutually decided between the purchaser and the manufacturer using their mutual experience and application engineering knowledge.

X1.2 With the knowledge that several types are available, care should be taken to ensure that production lots are the same in all respects as samples and that if a seller change is made, noticeable property or performance variations are possible.

TABLE X1.1 Typical Chemical Ranges Infiltrated Silver-Tungsten Carbide Contacts

	Composition,[A] Weight, %		
	Class A	Class B	Class C
Silver	38 to 42	48 to 52	63 to 67
Tungsten carbide	balance	balance	balance
Copper, max	0.5	0.5	0.5
Cobalt or nickel, max	0.5	0.5	0.5
Total impurities, max	1	1	1
	Typical Properties		
	Class A	Class B	Class C
Hardness, Rockwell B	95 to 105	86 to 96	50 to 65
Density, Mg/m^3	13.1	12.6	11.9
Electrical conductivity, % IACS	35 to 40	45 to 50	55 to 60
Theoretical density, min, %	96	96	96
	Properties		
	Class A	Class B	Class C
Modulus of rupture:[B]			
psi	120 000	95 000	80 000
MPa	827	655	552
Young's modulus:[B]			
psi	56×10^6	50×10^6	36×10^6
GPa	386	345	248
Tensile strength:[B]			
psi	55 000	40 000	39 500
MPa	379	276	272
Coefficient of expansion:[B]			
in./in.·°F	7.6×10^{-6}	8.25×10^{-6}	9.45×10^{-6}
m/m·K	13.7×10^{-6}	14.8×10^{-6}	17×10^{-6}
Thermal conductivity:[B]			
$Btu \cdot in./h \cdot ft^2 \cdot °F$	2808	4392	4968
W/m·K	405	633	716

[A] Analysis is regularly made for the elements for which specific limits are listed. If, however, the presence of "other" elements is suspected or indicated in the course of routine analysis, further analysis shall be made to determine that the total of these "other" elements and the listed impurities are not in excess of the total impurities limit.
[B] Items that are normally useful for engineering calculations in contact design but are not specified.

TABLE X1.2 Typical Chemical Ranges Press, Sintered, and Repressed Silver-Tungsten Carbide Contacts

	Composition[A] Weight, %		
	Class A	Class B	Class C
Silver	38 to 42	48 to 52	63 to 67
Tungsten carbide	balance	balance	balance
Copper, max	0.2	0.2	0.2
Nickel or cobalt, max	0.2	0.2	0.2
Total impurities, max	0.5	0.5	0.5
	Typical Properties		
	Class A	Class B	Class C
Hardness, Rockwell B (as repressed)	60 to 70	60 to 70	40 to 55
Hardness, Rockwell B (annealed)	55 to 65	55 to 65	35 to 45
Density, Mg/m^3	13.1	12.6	11.9
Theoretical density, min,%	95	95	95
Modulus of rupture[B]			
psi	70 000	62 000	60 000
MPa	483	427	414

[A] Analysis is regularly made for the elements for which specific limits are listed. If, however, the presence of "other" elements is suspected or indicated in the course of routine analysis, further analysis shall be made to determine that the total of these "other" elements and the listed impurities are not in excess of the total impurities limit.
[B] Items that are normally useful for engineering calculations in contact design but are not specified.