



# Standard Specification for Silver-Tungsten Electrical Contact Materials<sup>1</sup>

This standard is issued under the fixed designation B631; 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 specification covers electrical contact components made from silver-tungsten by powder-metallurgical procedures.

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

1.3 *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 Data Safety 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*:<sup>2</sup>

**B328 Test Method for Density, Oil Content, and Interconnected Porosity of Sintered Metal Structural Parts and Oil-Impregnated Bearings** (Withdrawn 2009)<sup>3</sup>

## 3. Ordering Information

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

3.1.1 Dimensions (see Section 7).

3.1.2 Chemical composition (see reference tables in the **Appendix X1** as a possible guide).

3.1.3 Physical properties (see Section 6 and **Appendix X1** as guideline).

3.1.4 Certification (see Section 13).

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

<sup>1</sup> 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.

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<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* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

## 4. Chemical Composition

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

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

## 5. Other Requirements

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

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

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

5.4 The typical properties of the four most common types of silver-tungsten contacts are given in the appendix.

## 6. Finishing of Contacts

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

## 7. Permissible Variations in Dimensions

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. Workmanship

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

## 9. Significance and Use

9.1 Proprietary methods for manufacture of these materials vary significantly among suppliers, and these methods influence such properties as arc erosion, contact resistance, and 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 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 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.

## 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 one time.

10.2 *Chemical Analysis*—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**.

10.2.1 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 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 shipment.

## 13. Certification

13.1 A certification, when requested by the purchaser, 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 contacts; powder metallurgy; silver; silver-tungsten; tungsten; tungsten-silver

## APPENDIX

### (Nonmandatory Information)

#### X1. Typical Property Values

##### X1.1 Scope

X1.1.1 The following information provides guidelines for users and manufacturers of silver-tungsten contact material. Typical ranges of chemistry and properties are given for the three most popular compositions, 27 silver/73 tungsten, 35 silver/65 tungsten, and 50 silver/50 tungsten. These properties are influenced by the particle size, shape, and distribution of tungsten, homogeneity, impurities or additives, and other manufacturing process variables (Note). The best choice for a given application should be decided mutually between the purchaser and supplier using their mutual experience and application of engineering knowledge.

NOTE X1.1—Table X1.1, Table X1.2, Table X1.3, and Table X1.4 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.

X1.2 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 vendor change is made, noticeable property or performance variations are possible.

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

	Composition, <sup>A</sup> weight %		
	Class A	Class B	Class C
Tungsten	remainder	remainder	remainder
Silver	25–29	33–37	47–51
Copper, max	0.2	0.2	0.2
Cobalt or nickel, max	1.0	1.0	1.0
Carbon, max	0.2	0.2	0.2
Total impurities, max	1.0	1.0	1.0
Properties			
Data for typical physical properties of infiltrated sintered silver-tungsten contacts are given in this table for contacts having a mean tungsten particle size as determined by a Fisher sub-sieve sizer of 1 to 6.5 μ m.			
	Class A	Class B	Class C
Hardness, Rockwell B	85–105	73–86	50–60
Density, Mg/m <sup>3</sup>	15.14–15.74	14.57–15.12	13.2–13.85
Electrical conductivity, % IACS	40–54	45–60	58–68
Theoretical density, min, %	96	96	96
Modulus of rupture, <sup>B</sup>			
psi	110 000–130 000	108 000–120 000	80 000–82 000
MPa	760–900	740–830	550–570
Young's modulus, <sup>B</sup>			
psi	39.00 × 10 <sup>6</sup>	35 × 10 <sup>6</sup>	28.00 × 10 <sup>6</sup>
MPa	270 × 10 <sup>3</sup>	240 × 10 <sup>3</sup>	190 × 10 <sup>3</sup>
Tensile strength, <sup>B</sup>			
psi	70 000	55 000	35 000
MPa	480	380	240
Coefficient of expansion, <sup>B</sup>			
in./in.°F	5.9 × 10 <sup>-6</sup>	6.75 × 10 <sup>-6</sup>	7.9 × 10 <sup>-6</sup>
m/m-K	10.6 × 10 <sup>-6</sup>	12.15 × 10 <sup>-6</sup>	14.4 × 10 <sup>-6</sup>
Thermal conductivity, <sup>B</sup>			
Btu-in./h-ft <sup>2</sup> °F	2920	3130	3130
W/m-K	420	451	451

<sup>A</sup> 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.

<sup>B</sup> Items that are normally useful for engineering calculations in contact design but are not specified.

**TABLE X1.2 Typical Chemical Ranges for High-Density Press and Sintered Silver-Tungsten Contacts**

	Composition, <sup>A</sup> weight %		
	Class A	Class B	Class C
Tungsten	remainder	remainder	remainder
Silver	25–29	33–37	42–46
Nickel, cobalt, or copper, max	1.50	1.50	1.50
Carbon, max	0.20	0.20	0.20
Total impurities, max	0.50	0.50	0.50
Properties			
Data for typical physical properties of pressed and sintered silver-tungsten contacts are given in this table for contacts having a mean tungsten particle size as determined by a Fisher sub-sieve sizer, or 1 to 4 μ m.			
	Class A	Class B	Class C
Hardness, Rockwell B	90–105	70–100	50–85
Density, Mg/m <sup>3</sup>	14.7–15.6	14.1–14.8	13.3–14.0
Electrical conductivity, % IACS	38–50	45–60	52–67
Young's modulus, <sup>B</sup>			
psi	32 × 10 <sup>+6</sup>	30 × 10 <sup>+6</sup>	25 × 10 <sup>+6</sup>
MPa	220 × 10 <sup>+3</sup>	210 × 10 <sup>+3</sup>	170 × 10 <sup>+3</sup>
Coefficient of expansion, <sup>B</sup>			
in./in.°F	5.9 × 10 <sup>-6</sup>	6.77 × 10 <sup>-6</sup>	7.78 × 10 <sup>-6</sup>
m/m-K	10.6 × 10 <sup>-6</sup>	12.2 × 10 <sup>-6</sup>	14.00 × 10 <sup>-6</sup>
Thermal conductivity, <sup>B</sup>			
Btu-in./h-ft <sup>2</sup> °F	2880	3160	3420
W/m-K	415	451	493

<sup>A</sup> 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.

<sup>B</sup> Items that are normally useful for engineering calculations in contact design but are not specified.

**TABLE X1.3 Typical Chemical Ranges for Pressed, Sintered and Repressed Silver-Tungsten Contacts**

	Composition, <sup>A</sup> weight %		
	Class A	Class B	Class C
Tungsten	remainder	remainder	remainder
Silver	25–29	33–37	48–52
Copper, max	0.2	0.2	0.2
Carbon, max	0.2	0.2	0.2
Total impurities, max	0.5	0.5	0.5
Properties			
Data for typical physical properties of repressed, sintered silver-tungsten contacts are given in this table for contacts having a mean tungsten particle size as determined by a Fisher sub-sieve size of 1 to 6.5 μm.			
	Class A	Class B	Class C
Hardness, Rockwell B	45–70	50–70	40–55
Density, Mg/m <sup>3</sup>	14.95–15.31	14.18–14.93	12.92–13.67
Electrical conductivity, % IACS	38–45	42–55	50–65
Theoretical density, min, %	95	95	95

<sup>A</sup> 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.

**TABLE X1.4 Typical Chemical Ranges for Low-Density Pressed and Sintered Silver-Tungsten Contacts**

	Composition, <sup>A</sup> weight %		
	Class A	Class B	Class C
Tungsten	remainder	remainder	remainder
Silver	25–29	33–37	46–52
Copper, max	0.20	0.20	0.20
Carbon, max	0.20	0.20	0.20
Total impurities, max	0.50	0.50	0.50
Properties			
Data for typical physical properties of pressed and sintered silver-tungsten contacts are given in this table for contacts having a mean tungsten particle size as determined by a Fisher sub-sieve size of 1 to 4 μm.			
	Class A	Class B	Class C
Hardness, Rockwell B	55–70	45–60	35–50
Density, Mg/m <sup>3</sup>	13.97–15.2	13.74–14.19	12.52–12.93
Electrical conductivity, % IACS	35–45	45–55	50–60
Young's modulus, <sup>B</sup>			
psi	32 × 10 <sup>+6</sup>	30 × 10 <sup>+6</sup>	25 × 10 <sup>+6</sup>
MPa	220 × 10 <sup>+3</sup>	210 × 10 <sup>+3</sup>	170 × 10 <sup>+3</sup>
Coefficient of expansion, <sup>B</sup>			
in./in.°F	5.9 × 10 <sup>-6</sup>	6.77 × 10 <sup>-6</sup>	7.78 × 10 <sup>-6</sup>
m/m-K	10.6 × 10 <sup>-6</sup>	12.2 × 10 <sup>-6</sup>	14.00 × 10 <sup>-6</sup>
Thermal conductivity, <sup>B</sup>			
Btu-in./h-ft <sup>2</sup> ·°F	2880	3160	3420
W/m-K	415	451	493

<sup>A</sup> 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.

<sup>B</sup> Items that are normally useful for engineering calculations in contact design but are not specified.

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