Designation: B541 – 01 (Reapproved 2012)

Standard Specification for Gold Electrical Contact Alloy[1]

This standard is issued under the fixed designation B541; 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 Department of Defense.

1. Scope

1.1 This specification covers a gold-rich, age-hardenable alloy in rod, wire, and strip form applicable to electrical contacts.

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

1.3 The following precautionary statement pertains to the test method portion only, Section 7, of this specification. *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 Material Safety Data Sheet (MSDS) 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]

B476 Specification for General Requirements for Wrought Precious Metal Electrical Contact Materials

E8 Test Methods for Tension Testing of Metallic Materials

E384 Test Method for Knoop and Vickers Hardness of Materials

3. Materials and Manufacture

3.1 Raw materials shall be of such quality and purity that the finished product will have the properties and characteristics prescribed in this specification.

3.2 The material shall be finished by such operations (cold working, annealing, turning, grinding, age hardening, etc.) as are required to produce the prescribed properties.

4. Chemical Composition

4.1 Material produced under this specification shall meet the requirements of Table 1 for chemical composition.

5. Condition

5.1 This specification covers the conditions and forms listed in Table 2.

6. Mechanical Properties

6.1 Mechanical properties shall conform to Table 3 and Table 4 as appropriate.

6.2 The contract or order may specify ultimate tensile strength, elongation, microhardness (Knoop or Vickers), hardness (Rockwell or Rockwell Superficial), or a combination of these mechanical properties as temper criterion. If the contract or order does not specify a temper criterion, then the criterion for temper designation will be ultimate tensile strength and elongation.

6.3 Mechanical properties of flattened wire, less than 0.012 in. (0.30 mm) thick shall conform to 6.1 (Table 5).

7. Test Methods

7.1 Test methods are in accordance with Specification B476.

7.2 All tension tests are in accordance with Test Methods E8 and tensile specimens are full cross-section size when practical.

7.3 Hardness is in accordance with Test Method E384. Test material 0.005 in. (0.13 mm) in thickness (diameter) and larger using a 100-gf indenter load. Test material less than 0.005 in. in thickness (diameter) using a 50-gf indenter load. Make a minimum of five hardness indentions on each specimen. Make all indentions so that the long axis of the Knoop indenter is parallel to the rolling or drawing direction of the material.

7.4 Perform chemical analysis by spectrochemical or wet analysis methods.

7.5 Conduct all tests at room temperature (65 to 85°F) (18 to 29°C).

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[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.

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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.

TABLE 1 Chemical Requirements

Element	Composition, Weight %	
	Nominal	Range
Gold	71.5	70.5–72.5
Platinum	8.5	8.0–9.0
Silver	4.5	4.0–5.0
Copper	14.5	13.5–15.5
Zinc	1.0	0.7–1.3
Total base metal impurities	...	0.2 max
Total platinum group metal impurities	...	0.2 max

TABLE 2 Conditions and Forms

Process	Symbol	Form		
		Wire	Strip	Rod
Annealed	A	X	X	X
Stress relieved	S-R	X	X	
Age hardened from solution annealed condition	HT-A	X	X	X
Age hardened from solution annealed and cold-worked condition	HT-CW	X	X	X

TABLE 3 Mechanical Properties of Wire (0.004 to 0.020-in. (0.12 to 0.5-mm) diameter)[A]

Property	Condition			
	A	S-R	HT-A	HT-CW
Tensile strength, ksi	85–110	130–170	130–165	150–200
Tensile strength, MPa	590–760	900–1170	900–1140	1030–1380
Elongation, % in 5 in. or 125 mm	20 min	5–15	7–14	2–10
Hardness, Knoop, HK_{100}[B]	180–240	270–340	280–350	310–380
Hardness, Vickers HV_{100}[B]	180–250	270–340	285–360	290–370

[A] See 6.2.
[B] See 7.3.

TABLE 4 Mechanical Properties of Wire (0.021 to 0.080-in. (0.51 to 0.200-mm) diameter)[A]

Property	Condition			
	A	S-R	HT-A	HT-CW
Tensile strength, ksi	80–110	130–170	130–160	145–195
Tensile strength, MPa	550–760	900–1170	900–1100	1000–1340
Elongation, % in 2 in. or 50 mm	16 min	4–14	5–14	2–10
Hardness, Knoop HK_{100}[B]	180–240	270–340	270–340	290–370
Hardness, Vickers HV_{100}[B]	180–250	270–340	285–360	290–370

[A] See 6.2.
[B] See 7.3.

TABLE 5 Mechanical Properties of Strip (0.003 to 0.020-in. (0.12 to 0.5-mm) thick)[A]

Property	Condition			
	A	S-R	HT-A	HT-CW
Tensile strength, ksi	85–115	125–165	125–155	140–180
Tensile strength, MPa	590–790	860–1140	860–1070	970–1240
Elongation, % in 2 in. or 50 mm	12 min	3–16	3–12	2–10
Hardness, Knoop, HK_{100}[B]	200–250	270–340	270–340	290–370
Hardness, Vickers HV_{100}[B]	180–250	270–340	275–350	285–365

[A] See 6.2.
[B] See 7.3.

8. General Requirements

8.1 Specification B476 shall apply to all materials produced to this specification.

9. Inspection and Testing

9.1 Material furnished under this specification shall be inspected and tested by the manufacturer as follows:

9.1.1 Visual inspection at 10× magnification,
9.1.2 Tension or hardness tests, or both, temper verification,
9.1.3 Dimensional inspection, and
9.1.4 Chemical analysis when indicated by the purchase order.

10. Keywords

10.1 contacts; electrical contacts; gold alloy; gold-platinum-silver; low contact resistance; low energy contact; non arcing contact

APPENDIX

(Nonmandatory Information)

X1. REFERENCE PROPERTIES OF GOLD ELECTRICAL CONTACT ALLOY

X1.1 Table X1.1 lists typical property values that are useful for engineering calculations.

TABLE X1.1 Typical Physical Properties

Property	Units	Condition			
		A	S-R	HT-A	HT-CW
Resistivity	Ω·cmil/ft	135	125	87	87
	μΩ·cm	22.4	20.8	14.5	14.5
Conductivity	percent IACS	7.7	8.3	12.2	12.2
Density	g/cm^3	15.9	15.9	15.9	15.9
	Troy oz/$in.^3$	8.37	8.37	8.37	8.37
Thermal expansion,	$°F^{-1} \times 10^{-6}$	7	7	7	7
70–212°F (21–100°C)	$°C^{-1} \times 10^{-6}$	12.6	12.6	12.6	12.6
Young's modulus	million psi	16	16	16	16
	GPa	110	110	110	110
Shear modulus[A]	million psi	...	...	5.5	5.5
	GPa	...	...	38	38
Proportional limit	ksi	70	120	115	130
	MPa	480	830	790	900
Fatigue strength	ksi	35	...	...	30
Rotate/bend 10^8 cycles	MPa	250	...	...	210
Solidus temperature	°C	925	925	925	925
Softening voltage	mV	230	...	...	150
Melting voltage	mV	350	...	...	360
Thermal emf versus Pt	mV/°F	+1.7	+2.2	+2.2	+2.2
	mV/°C	+3	+4	+4	+4

[A] Also known as modulus of rigidity or torsional modulus, *G*.