



# Standard Specification for Gold Electrical Contact Alloy<sup>1</sup>

This standard is issued under the fixed designation B 541; 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.

*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:<sup>2</sup>

**B 476** Specification for General Requirements for Wrought Precious Metal Electrical Contact Materials

**E 8** Test Methods for Tension Testing of Metallic Materials

**E 384** Test Method for Microindentation 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.

**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   |

## 5. Condition

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

**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                                    | HT-A   | X    | X     | X   |
| annealed condition                                            |        |      |       |     |
| Age hardened from solution annealed and cold-worked condition | HT-CW  | X    | X     | X   |

## 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)**.

<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.

TABLE 3 Mechanical Properties of Wire (0.004 to 0.020-in. (0.12 to 0.5-mm) diameter)<sup>A</sup>

| 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 <sub>100</sub> <sup>B</sup>  | 180–240   | 270–340  | 280–350  | 310–380   |
| Hardness, Vickers HV <sub>100</sub> <sup>B</sup> | 180–250   | 270–340  | 285–360  | 290–370   |

<sup>A</sup> See 6.2.<sup>B</sup> See 7.3.TABLE 4 Mechanical Properties of Wire (0.021 to 0.080-in. (0.51 to 0.200-mm) diameter)<sup>A</sup>

| 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 <sub>100</sub> <sup>B</sup>   | 180–240   | 270–340  | 270–340  | 290–370   |
| Hardness, Vickers HV <sub>100</sub> <sup>B</sup> | 180–250   | 270–340  | 285–360  | 290–370   |

<sup>A</sup> See 6.2.<sup>B</sup> See 7.3.TABLE 5 Mechanical Properties of Strip (0.003 to 0.020-in. (0.12 to 0.5-mm) thick)<sup>A</sup>

| 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 <sub>100</sub> <sup>B</sup>  | 200–250   | 270–340  | 270–340  | 290–370  |
| Hardness, Vickers HV <sub>100</sub> <sup>B</sup> | 180–250   | 270–340  | 275–350  | 285–365  |

<sup>A</sup> See 6.2.<sup>B</sup> See 7.3.

## 7. Test Methods

7.1 Test methods are in accordance with Specification B 476.

7.2 All tension tests are in accordance with Test Methods E 8 and tensile specimens are full cross-section size when practical.

7.3 Hardness is in accordance with Test Method E 384. 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).

## 8. General Requirements

8.1 Specification B 476 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                               | $\Omega$ -cmil/ft                      | 135       | 125   | 87    | 87    |
|                                           | $\mu\Omega$ -cm                        | 22.4      | 20.8  | 14.5  | 14.5  |
| Conductivity                              | percent IACS                           | 7.7       | 8.3   | 12.2  | 12.2  |
| Density                                   | g/cm <sup>3</sup>                      | 15.9      | 15.9  | 15.9  | 15.9  |
|                                           | Troy oz/in. <sup>3</sup>               | 8.37      | 8.37  | 8.37  | 8.37  |
| Thermal expansion,<br>70–212°F (21–100°C) | $^{\circ}\text{F}^{-1} \times 10^{-6}$ | 7         | 7     | 7     | 7     |
|                                           | $^{\circ}\text{C}^{-1} \times 10^{-6}$ | 12.6      | 12.6  | 12.6  | 12.6  |
| Young's modulus                           | million psi                            | 16        | 16    | 16    | 16    |
|                                           | GPa                                    | 110       | 110   | 110   | 110   |
| Shear modulus <sup>A</sup>                | 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 <sup>8</sup> cycles        | MPa                                    | 250       | ...   | ...   | 210   |
| Solidus temperature                       | $^{\circ}\text{C}$                     | 925       | 925   | 925   | 925   |
| Softening voltage                         | mV                                     | 230       | ...   | ...   | 150   |
| Melting voltage                           | mV                                     | 350       | ...   | ...   | 360   |
| Thermal emf versus Pt                     | mV/ $^{\circ}\text{F}$                 | + 1.7     | + 2.2 | + 2.2 | + 2.2 |
|                                           | mV/ $^{\circ}\text{C}$                 | + 3       | + 4   | + 4   | + 4   |

<sup>A</sup> Also known as modulus of rigidity or torsional modulus, G.

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