Designation: B540 – 21

Standard Specification for Palladium Electrical Contact Alloy[1]

This standard is issued under the fixed designation B540; 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 an alloy containing palladium, silver, copper, gold, platinum, and zinc in the form of wire, rod, and strip for 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 It is the responsibility of the user 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.

1.4 The following safety hazard caveat pertains only to the test methods portion, Section 6 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 Safety Data Sheet (SDS) for this product/material as provided by the manufacturer, to establish appropriate safety, health, and environmental practices, and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

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

E8/E8M Test Methods for Tension Testing of Metallic Materials

E384 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, heat treating, annealing, turning, grinding, pickling) as are required to produce the prescribed properties.

4. Chemical Composition

4.1 Material produced under the specification shall meet the requirements of chemical composition shown in Table 1.

5. Mechanical Properties

5.1 The contract or order may specify ultimate tensile strength, elongation, microhardness (Knoop or Vickers), or a combination of these mechanical properties (as listed in Table 2, Table 3, and Table 4) 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.

5.1.1 Fully age-hardened temper is also known as heat-treated age-hardened or as age-hardened.

5.1.2 Partially age-hardened temper (where higher material ductility is retained due to either lower temperature or time of aging, or both) is also known as ductile heat-treated age-hardened or as ductile-hardened.

6. Test Methods

6.1 Test methods shall be in accordance with Specification B476.

6.1.1 Knoop hardness tests shall be in accordance with Test Method E384. Material 0.005 in. (0.13 mm) in thickness (diameter) and larger shall be tested using a 100-g indenter load. Material less than 0.005 in. (0.13 mm) in thickness (diameter) shall be tested using a 50-g indenter load. A

[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 %
Palladium	34.0–36.0
Silver	29.0–31.0
Copper	13.5–14.5
Gold	9.5–10.5
Platinum	9.5–10.5
Zinc	0.8–1.2
Total platinum group metal impurities (iridium, osmium, rhodium, ruthenium)	0.1 max
Total base metal impurities	0.2 max

TABLE 2 Mechanical Properties of Wire[A] (0.004 to 0.020 in. (0.1 to 0.5 mm) diameter)

Property	Temper			
	Solution-Annealed	Stress-Relieved	Partially Age-Hardened	Fully Age-Hardened
Tensile strength, ksi	110–130	140–170	160–190	160–200
Tensile strength, MPa	760–900	970–1170	1100–1310	1100–1380
Elongation, % in 2 in. (51 mm)	20 min	10–20	8–18	1–10
Hardness, Knoop[B]	200–260	280–340	320–370	350–410
Hardness, Vickers, 100-g load (50-g under 0.005-diameter)	190–250	265–340	320–380	330–400

[A] The limits to all properties apply only to the sizes specified.
[B] See 6.1.1.

TABLE 3 Mechanical Properties of Wire[A] (Over 0.020 to 0.040 in. (0.5 to 1.0 mm) diameter)

Property	Temper			
	Solution-Annealed	Stress-Relieved	Partially Age-Hardened	Fully Age-Hardened
Tensile strength, ksi	105–130	130–170	155–180	160–200
Tensile strength, MPa	720–860	900–1170	1070–1240	1100–1380
Elongation, % in 2 in. (51 mm)	15 min	8–25	8–25	1–10
Hardness, Knoop[B]	200–260	280–340	310–360	340–400
Hardness, Vickers, 100-g load	190–250	265–340	320–380	330–400

[A] The limits to all properties apply only to the sizes specified.
[B] See 6.1.1.

TABLE 4 Mechanical Properties of Strip[A] (0.003 to 0.020 in. (0.075 to 0.5 mm) thick)

Property	Temper			
	Solution-Annealed	Stress-Relieved	Partially Age-Hardened	Fully Age-Hardened
Tensile strength, ksi	110–135	135–160	150–185	160–200
Tensile strength, MPa	760–930	930–1100	1030–1280	1100–1380
Elongation, % in 2 in. (51 mm)	12 min	8–25	8–25	1–10
Hardness, Knoop[B]	200–260	280–340	300–360	340–400
Hardness, Vickers 100-g load (50-g load under 0.005 thick)	185–255	265–340	320–380	330–400

[A] The limits to all properties apply only to the sizes specified.
[B] See 6.1.1.

minimum of five hardness indentations shall be made on each specimen. All indentations shall be made so that the long axis of the indenter is parallel to the rolling or drawing direction of the material. The hardness value reported shall be the average of the five indentations.

6.1.2 All tension test specimens shall be full cross-section size when practical (see Test Methods E8/E8M).

6.1.3 All tests shall be conducted in room temperature, 65 to 85 °F (18.3 to 29.4 °C).

6.2 Chemical analysis shall be performed by spectrochemical or wet analysis methods.

7. Inspection and Testing

7.1 Material furnished under this specification shall be inspected and tested by the manufacturer as listed below:

7.1.1 Visual inspection at 10× magnification,

7.1.2 Tension or hardness tests, or both, for temper verification,

7.1.3 Dimensional inspection, and

7.1.4 Chemical analysis when indicated by the purchase order.

8. Keywords

8.1 contact; electrical contact material; palladium alloy; precious metal

APPENDIX

(Nonmandatory Information)

X1. REFERENCE PROPERTIES OF PALLADIUM ALLOY ELECTRICAL CONTACT MATERIAL

X1.1 Table X1.1 provides a list of typical property values which are useful for engineering calculations in electrical contact design and application.

TABLE X1.1 Typical Physical Properties

	Solution-Annealed	Stress-Relieved	Partially Age-Hardened	Fully Age-Hardened
Resistivity, μΩ·cm	34.9	33.2	31.6	31.6
Density, Mg/m^3	11.8	11.8	11.8	11.8
Solidus temperature, °C	1015	1015	1015	1015
Linear coefficient of thermal expansion/°C (23-100°C)	13.5×10^{-6}	13.5×10^{-6}	13.5×10^{-6}	13.5×10^{-6}
Thermal emf versus platinum (0-100°C), μ V/°C	−10	−9	−8	−8
Softening voltage, mV	220	220	220	220
Melting voltage, mV	385	...	400	400
Fatigue strength (rotating-bending) at 10^8 cycles:				
ksi	50	50	50	50
MPa	345	345	345	345
Modulus of elasticity in tension:				
ksi	17×10^3	17×10^3	17×10^3	17×10^3
MPa	117×10^3	117×10^3	117×10^3	117×10^3
Proportional limit:				
ksi	90	135	135	145
MPa	620	930	930	1000