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Standard Guide for Silver-Tin Oxide Contact Material [1]

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1. Scope

1.1 This standard provides guidelines for users and manufacturers of silver-tin oxide material produced in strip, rod, wire, and part form for electrical contact applications.

1.2 Silver-tin oxide refers to contact material containing silver, tin oxide, and other metal oxide which may be used for either improving the processing or performance of the material.

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 establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.4 It is the responsibility of the user to become familiar with all hazards including those identified in the appropriate Material Safety Data sheet for this product/material or provided by the manufacturer.

2. Referenced Documents

2.1 *ASTM Standards:*

B 311 Test Method for Density of Cemented Carbides [2]

B 476 Specification for General Requirements for Wrought Precious Metal Electrical Contact Materials [3]

C 914 Test Method for Bulk Density and Volume of Solid Refractories by Wax Immersion [4]

NOTE 1—Test Method B 311 is applicable to fully dense forms. Specification B 476 is applicable to strip, rod, or wire only. Test Method C 914 is applicable to forms less than 99 % dense.

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *lot*—(usage involving discrete manufactured parts)—all parts of the same form, and dimensions, from the same alloy melt or batch of particulate (if manufactured by consolidation), processed under the same conditions, and submitted for inspection at the same time.

4. Significance and Use

4.1 The methods for manufacture (proprietary or otherwise) 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 guide cannot ensure performance control in the application. As part of the qualification on initial samples it is recommended that the user electrically test the materials in a functional manner for all devices applicable to the material's use. This guide 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 how to provide reasonable assurance that future lots will be similar in properties and microstructure to the initial test of sample contacts supplied.

5. Materials and Manufacture

5.1 Various processes may be utilized to produce silver-tin oxide contact materials. Internal oxidation of a silver-tin alloy is a viable method. However, if oxidized at relatively low pressures, a binary silver-tin alloy develops a stable layer of tin oxide at the surface which inhibits further oxidation of the material. Because of this phenomenon, usually at least a third element (such as indium) is added to the alloy in order to promote internal oxidation. Oxidation may be carried out under elevated oxygen pressure and also at various temperatures; oxidation conditions determine size and distribution of the resulting oxide particles. Other manufacturing processes utilize powder metallurgical techniques. Silver- and tin-oxide powders may be blended and consolidated by heat or pressure, or both, into wire or strip suitable for further processing, or may be blended and sintered directly into contacts. Methods that can be used to prepare silver- and tinoxide powder mixtures include either coprecipitation or sequential precipitation of silver and tin compounds from aqueous solutions, coating of tin-oxide particles by precipitation of silver from an aqueous

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[2] *Annual Book of ASTM Standards*, Vol 02.05.

[3] *Annual Book of ASTM Standards*, Vol 03.04.

[4] *Annual Book of ASTM Standards*, Vol 15.01.

solution, and powder atomization of a silver-base alloy followed by internal oxidation of the atomized powder.

5.1.1 Silver-tin oxide materials are used in various tempers dependent on the attachment and fabrication process utilized.

5.1.2 For purposes of attachment or device performance, silver-tin oxide contact material is often produced with a conductive or brazable layer of material or backing. Incorporation of such a layer is often an integral part of the silver-tin oxide manufacturing process.

5.1.3 Silver-tin oxide materials vary from full theoretical density to about 95 % of theoretical density depending on the specific manufacturing period.

5.1.4 The tin-oxide particle size and uniformity in combination with the contact density and chemical composition (see 6.2) determine the performance characteristics of the electrical contacts in service. It may be of importance to specify the microstructure, in which case, it is recommended that photographs of acceptable microstructures be agreed upon between the producer and the user, as well as photographs illustrating unacceptable type of microstructures. It is highly recommended that these attributes be considered in making selection or replacement decisions and qualification tests be performed by the user or the purchaser including functional electrical tests for new or altered selections and manufacturing sources.

5.2 No substantive change shall be made in the manufacturing technique of the silver-tin oxide contact material without notification to and approval by the user.

6. Chemical Composition

6.1 Material produced under this guide shall meet the composition of silver and tin oxide agreed upon by the vendor and the user. Popular compositions and suggested tolerances are given in Table 1. In the case of material supplied with a distinct brazable or conductive backing, such backing shall not be considered to be included in the silver-tin oxide material composition.

6.2 *Additives and Impurities*:

6.2.1 A wide variety of chemical additives have been made to silver-tin oxide materials for processing and performance purposes. The merits of these additions remain a point of contention. Any component over 0.1 % (for example) is deemed to be an additive and is expected to be controlled in its amount by the producer. Additionally, various impurities may remain in these materials from raw materials or processing which have been found to be either detrimental or helpful depending on the residual level and the individual application. Chemical requirements for such elements and analytical methods to be employed shall be mutually agreed upon between the producer and the user.

6.2.2 It should be noted that the operating characteristics of silver-tin oxide materials with different additives may be very different. Certain operating characteristics such as welding resistance, electrical erosion, and others may improve or degrade as a result of additives. As a result of differences in these materials due to both compositional and processing differences, no substitutions in material should be made without operational testing of new materials.

6.3 No substantive change shall be made to additives or impurities without notification to and approval by the user.

TABLE 1 Suggested Chemistries[A] and Theoretical Densities

	92 Silver/8 Tin Oxide	90 Silver/10 Tin Oxide	Silver/12 Tin Oxide
	Chemistry		
Tin oxide, weight %	8.0 ± 1.0	10.0 ± 1.0	12.0 ± 1.0
Silver, min, weight %	91.0	89.0	87.0
Other elements	(see 6.2)		
	Theoretical Densities at Nominal Composition:		
Mg/m^3		9.8	9.7
troy oz/in.^{3}		5.2	5.1

[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.

7. Other Properties

7.1 Mechanical properties of silver-tin oxide contact materials are very dependent on the manufacturing method. For this reason, only guideline properties for some discrete part contacts of popular silver-tin oxide compositions in the annealed state are given.

7.1.1 Properties in coined, repressed, headed, or other states will vary considerably due to the effects of cold working. Additives and oxidation conditions may also alter these properties.

7.1.2 Guideline properties are given in Table 2 for silver-tin oxide compositions in wire form.

7.2 Specific properties and tolerances shall be established and agreed to between the producer and user for any particular commercial designation of silver-tin oxide material and temper required.

8. Sampling and Inspection

8.1 Material or parts furnished under this guide shall be inspected by the producer listed as follows. Results of such inspection shall conform to values agreed to between the producer and user.

8.1.1 Strip and wire procured to temper shall be sampled and tested in accordance with Specification B 476 (when specified and applicable).

8.1.1.1 Such other properties as are required to verify the quality of the material produced under this guide.

8.1.2 Discrete contact parts produced under this guide shall be sampled and tested on a lot basis. However, for the purpose of this guideline, a lot is defined in 3.1.1.

8.1.2.1 For dimensional conformance.

8.1.2.2 Other properties as are required to verify the quality of the material produced under this guide.

9. Rejection and Rehearing

9.1 Material that fails to conform to the requirements of this guide may be rejected. Rejection should be reported to the producer or supplier promptly within 30 days of receipt of the shipment and in writing. When results of the tests are not satisfactory, the producer or supplier may make claim for a rehearing.