United States Patent [19]

Shibata

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[54] **SILVER-METAL OXIDE CONTACT MATERIALS**

[75] Inventor: **Akira Shibata,** Yokohama, Japan

[73] Assignee: **Chugai Denki Kogyo Kabushiki-Kaisha,** Tokyo, Japan

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.**... **75/173 R**
[51] **Int. Cl.**.. **C22c 5/00**
[58] **Field of Search**................................. 75/173 A

[56] **References Cited**

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Primary Examiner—L. Dewayne Rutledge
Assistant Examiner—E. L. Weise
Attorney, Agent, or Firm—Shlesinger, Fitzsimmons & Shelsinger

[57] **ABSTRACT**

A composite electrical contact material consisting of an alloy composed of 6 to 12 weight percent of indium, and 0.5 to 5 weight percent of tin, the balance being silver, said alloy being formed into a strip or electrical contact shape and subjected to internal oxidation. Less than 0.5 weight percent of an element of the iron family is added to the alloy when it contains more than 2.5 weight percent of tin.

5 Claims, No Drawings

SILVER-METAL OXIDE CONTACT MATERIALS

This invention relates to silver-metal oxide contact materials.

While silver-cadmium oxides are popular as a composite contact material, practical examples of the contact material consisting of silver and oxides other than cadmium oxides that may be produced by the method of internal oxidation are rather few. In effect, material consisting of silver and cadmium oxides which are internally oxidized has excellent anti-fusibility and, for this reason, it is considered an indispensable material for producing electrical contacts to be used for industrial devices especially under medium load operating conditions. Many other oxides treated in the past in various literature were used practically for producing electrical contacts by the internal oxidation process on very rare occasions, owing to the weakness observed in contact resistance, anti-weld characteristic, service life and other requirements for electrical contacts.

Among these oxides, indium oxides are noticeable ones, because a silver alloy containing as much as 12 weight percent of indium is internally oxidizable and, further because this alloy has preference over silver-cadmium alloy from the view point of combatting the problem of pollution. This alloy, however, has not been adopted widely by reason of the formation of acicular structures in the matrix in the course of the internal oxidation, thereby inhibiting the formation of dispersed nuclei of oxidized precipitates therein. The addition of trace amounts of such elements as Mn, Co, Mg, Zr or the metals of iron group into the alloy would work to a considerable extent for comminuting crystals or retarding the growth of coarse crystals. The alloy internally oxidized with the addition of such metallic elements had, indeed, an improved structure, however, it was still inferior to the Ag-CdO alloy of comparable composition in point of anti-weld characteristic and anti-arc properties. Though it was impossible to determine whether the produced indium oxide was either In_2O, InO or In_2O_3 because of the low partial pressure of oxygen penetrated to the alloy, this result was against our theoretical assumption that the refractory properties of the indium oxide having the highest oxide concentration must be better than those of CdO.

The inventor has made a study of components which can be added to a silver-indium alloy for improving the refractory property of indium oxides thereof, and has found that the addition of Sn is effective for the purpose.

Accordingly, in this invention, indium oxides are precipitated in the silver matrix as compound oxides with Sn with the progress of the internal oxidation, by adding Sn in more than 0.5 weight percent, thus producing the hard contact material dispersed with refractory oxides. The hardness, refractoriness and anti-weld characteristic of the contact material thus obtained were found to be equal or even superior to those of silver-cadmium alloy material having comparable composition. It is found that when the weight percentage of tin falls below 0.5 weight %, the refractoriness of the material is adversely affected on account of the lowered oxide concentration. It is also found that addition of more than 2.5 weight % of tin retards the progress of the internal oxidation and, as in the case of the Ag-CdO alloy, the aforementioned elements, such as those of the iron family, have to be added in trace amounts to make the structure more uniform or even.

The excellent properties of the contact material of this invention are exhibited especially in cases where high current-breaking performance is required. This improved anti-weld characteristic of the contact material of the present invention may be attributed to the fact that when the indium oxide has expelled its oxygen in the silver matrix and has been turned into solid solute, its vapor pressure becomes low, and re-oxidization takes place due to the elevated temperature caused by arc generation, and thus the oxide concentration on the surface of the material is not lowered as in the case of Ag-CdO alloy material and contacts made thereof.

EXAMPLE 1

The metal alloys having the compositions shown in the following Table 1 were formed by melting them into plates clad with silver on their back surfaces. These test samples, 6 mm in diameter and 1.5 mm in thickness, were subjected to an internal oxidation at about 700°C and under the pressure of 3 atm of oxygen. The samples were tested as to their hardness, ASTM wear rate and anti-weld characteristic. The test results are given in said Table 1, by which it is confirmed that the same value of anti-weld characteristic as that of Ag-CdO alloy material having comparable composition could be obtained by addition of 0.5 to 2.5 weight % of Sn, and that the stable indium oxides could be obtained by oxidizing indium with such amount of Sn. These results clearly show that the Ag-In alloy material can be used satisfactorily for Ag-CdO alloy material, to say nothing of valuable effects on combatting the problem of environmental pollution.

Table 1

Samples	Hardness (HRF)	Wear Amount (mg.) on ASTM test	Current (A) for the occurrence of Welding
Ag-Cd 10%	50	8.0	3,000
Ag-In 10%	70	10.0	2,000
Ag-Cd 10%, Ni 0.2%	45	6.0	2,000
Ag-In 10%, Ni 0.2%	65	8.5	2,000
Ag-Cd 10%, Sn 2%, Co 0.1%	80	8.5	6,000
Ag-In 10%, Sn 2%, Co 0.1%	80	8.0	6,000

Table 2

Samples	Number of Occurrence of Weld
(1) Ag-Cd 15%	4
(2) Ag-In 12%	8
(3) Ag-In 10%, Sn 3%, Ni 0.2%	0

The ASTM wear amounts in Table 1 were measured under the following conditions:

Voltage: 210 V, Current: 50 A, Load: L (pf=0.2), Operating frequency: 60 times/min., Total operation times: 100,000, Contact pressure: 400 g., and Opening force: 600 g.

The current in Table 1 at which welding occured on the samples, was measured under the following conditions:

Contact pressure: 400 g., Discharge current: V=10, **20, 30, 40, 50, 60, 70, 80, 100, 110, 120, 130, 140, 150, 160,** and Peak current: Im=28.6 V(A)

EXAMPLE 2

A further comparative test was carried out on the antiweld characteristic of the known silver-cadmium and silverindium oxide alloy materials and the present invention contact material obtained by conducting the internal oxidation with the material consisting of 8 to 12 % of indium, 2.6 to 5 % of Sn, and less than 0.5 weight % of the elements of the iron group, the balance being silver. The result of the test is given in the Table 2 at page 5. The test conditions for the Table 2 are as follows:

Voltage: D.C. 200 V, Initial current: 5,700 A, and Contact pressure: 200 g.

Occurrence of welding was measured 20 times for five specimens of each test sample. The sample (3) in the

Table 2 represents a product of this invention obtained through the internal oxidation of the material of the composition given in said Table, which was 6 mm in diameter and 2 mm in thickness.

What is claimed is:

1. A composite electrical contact material consisting of an alloy composed of 6 to 12 weight percent of indium, and 0.5 to 5 weight percent of tin, the balance being silver, said alloy being formed into a desired configuration and subjected to an internal oxidation.

2. A composite electrical contact material as claimed in claim **1**, in which the alloy contains less than 0.5 weight percent of element of the iron family.

3. A composite electrical contact material as claimed in claim **2**, in which indium is contained in the alloy at 8 to 12 weight percent, and tin is contained at 2.6 to 5 weight percent.

4. A composite electrical contact material as claimed in claim **2**, wherein the alloy contains more than 2.5 weight percent of tin.

5. A composite electrical contact material as claimed in claim **1**, wherein the alloy contains less than 0.5% of nickel.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,874,941 Dated April 1, 1975

Inventor(s) Akira Shibata

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the front page of the patent, in paragraph [22], the filing date should read -- February 14, 1974 --, rather than "February 14, 1973". In paragraph [30], line 2, "Mar. 20, 1973" should read -- Mar. 22, 1973 --.

Signed and Sealed this

Fifteenth **Day of** *November 1977*

[SEAL]

Attest:

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