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(54) **Electrical contact materials, and methods of making the same.**

(57) Electrical-contact materials made from internally oxidized Ag alloys of the Ag-SnO system.
The alloys contain 0.5 - 12 wt % of Sn,
0.5 - 15 wt % of In or 0.01 - 1.5 wt % of Bi,
balance Ag.
As it was found that, after the internal oxidation treatment, the dispersion of metal oxides was not uniform and segregation occurred, a new method of manufacturing these materials was used.
As contact surface the section that was most remote from the face where the oxidation started was used. The alloy can be manufactured with a thickness slightly larger than twice the desired thickness of the final product, fixedly sandwiched between thin pure silver layers, internally oxidized and cut horizontally in two; the depletion zone, containing little or no oxides, disappears by this cutting operation.

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ELECTRICAL CONTACT MATERIALS, AND METHODS OF MAKING THE SAME

This invention relates to electrical contact materials, in particular internally oxidized Ag-SnO system alloy electrical contact materials, and to methods of making the same.

Lately, Ag alloys which contain 0.5 to 12 weight % of Sn and which have been internally oxidized, have become widely used as electrical contact materials in various electrical devices such as switches, contactors, relays and circuit breakers.

These Ag alloys which have been melted, cast, and rolled or drawn, and are generally in the form of thin plates with or without backing of thin pure Ag plates joined to the side of the Ag alloy thin plates, are internally oxidized by subjecting them to an oxygen atmosphere under pressure. Such alloys are different from those sintered Ag-metal oxide alloys which are made by mixing matrix Ag powders with powders of the metal oxides and sintering them. One noticeable difference is that the former, viz. internally oxidized Ag-Sn system alloys, are far superior to the latter in respect of their structural density, while the latter have a more uniform dispersion of metal oxides than the former. The latter may be very readily consumed in too rapid and frequent switching operations. Oxygen which has penetrated into the Ag alloys as time passes, oxidizes metallic solute elements in the alloys and precipitates them as minute metallic oxides distributed in their Ag matrices. Such metallic oxidized precipitates afford refractoriness and consequently anti-welding properties to the Ag alloys. The backing thin pure Ag plates, when they are employed, work as mediums for brazing the oxidized Ag alloy contact materials to support or base metals of electrical contacts.

It has been observed, however, that when Ag alloys of the above-mentioned kind are internally oxidized, metallic solute elements in the Ag alloys do not precipitate and distribute evenly in their Ag matrices, but they tend to precipitate at a high concentration about outer areas which are subjected directly to oxygen. Such precipitation of metallic oxides at outer areas produces their segregation about the outer areas, particularly at top surfaces, and bring in turn depletion layers of a not negligible thickness which lie between the top and bottom surfaces of the Ag alloys, when they are internally oxidized from both sides thereof. The segregations of metallic oxides at a high concentration about outer surfaces of electrical contact materials make the outer surfaces physically too hard, and produce electrically a high contact resistance of the materials especially at an initial stage of operation and consequently an excessive temperature increase. In practice, such segregations about the outer areas are often shaved off, for example filed off. This is not only laborious, but also it makes it difficult to reuse filings of the outer areas, since they are contaminated by filings of the files.

Compared to internally oxidized Ag-Sn system alloys, internally oxidized Ag-Cd system alloys have a more uniform dispersion of metal oxides. This is chiefly because the diffusion velocity of Cd in a silver matrix is inherently well balanced with the diffusion velocity of oxygen in the internal oxididation, while the respective diffusion velocities are not so well balanced in the case of internal oxidation of Ag-Sn system alloys. For this reason, electrical contact materials made of internally oxidized Ag-Cd system alloys and methods for preparing them are not relevant when considering the preparation of Ag-Sn system alloys and the internal oxidation thereof.

In any case, the segregation of tin oxides about contact surfaces makes them too hard, and often brings about cracks of the surfaces. High electrical contact resistances especially at an initial stage of operation of electrical contacts made from internally oxidized Ag-Sn alloys result from the segregation or excessive concentration of tin oxides about top surfaces. Unduly high temperature increase of contacts also results from the segregation.

In order to avoid the production of such segregations, there has been developed by the present inventor certain methods such as disclosed in U.S. Patent No. 4,457,787 in which vacant lattice voids are produced in Ag alloys by absorption with hydrogen for example, and in the course of internal oxidation solute melts fill the voids and precipitate as oxides at the oxide nuclei on an atomic scale, while diffusing only to such an extent that they reach most adjacent voids, and consequently avoiding any segregation and depletion thereof. Also, U.S. Patent No. 4,472,211 discloses materials wherein a high contact resistance, which is caused by high concentration or supersaturation of metal oxides including tin oxides about a contact surface, is avoided by having solute metals sublimated, reduced or extracted about the contact surface before the internal oxidation thereof.

The aforementioned depletion layers in which metallic oxides are completely absent or are extremely thin, can hardly withstand severe switching operations, since they have poor refractoriness. Therefore, when a contact material having a depletion layer between its upper contact surface and lower surface is used until worn to the depletion layer, its life ends. This means that while the lower half of the contact material which lies below the depletion layer can join with the upper half above the depletion layer to disperse heat generated by switching operations and to give a desired height of the material, it cannot be active as a contact surface. Often, the existence of such a lower half of the contact material is meaningless.

The present invention therefore aims to provide internally oxidized Ag-SnO system alloy electrical contact materials having contact surfaces of a moderate initial contact resistance and having no depletion layer, and a method of manufacturing such contact materials, not using methods such as disclosed in the above-mentioned U.S. Patents which are difficult to adequately control.

The present invention in one aspect provides an internally oxidized Ag-SnO system alloy electrical contact material, obtained by the complete internal oxidation of an alloy comprising 0.5 - 12 weight % of Sn, and 0.5 - 15 weight % of In or 0.01 - less than 1.5 weight % of Bi, the said alloy optionally including one or more metallic elements selected from 0.1 - 5 weight % of Cd, 0.1 - 2 weight % of Zn, 0.1 - 2 weight % of Sb, 0.01 - 2 weight % of Pb, and 0.1 - less than 2 weight % of In, characterized by having a forwardmost area of the internal oxidation along its progressive direction made as a contact surface.

The invention in another aspect provides an internally oxidized Ag-SnO system alloy electrical contact material, which comprises a contact portion of a desired thickness made from an Ag alloy comprising 0.5 - 12 weight % of Sn, and 0.5 - 15 weight % of In or 0.01 - less than 1.5 weight % of Bi, the said alloy optionally including one or more metallic elements selected from 0.1 - 5 weight % of Cd, 0.1 - 2 weight % of Zn, 0.1 - 2 weight % of Sb, 0.01 - 2 weight % of Pb, and 0.1 - less than 2 weight % of In, and which alloy is at least twice as thick as the said desired thickness and additionally has an expected thickness of a depletion layer to be produced in the alloy, has been completely internally oxidized by having it fixedly sandwiched between pure silver thin layers, and horizontally cut in two, simultaneously removing the depletion layer therefrom.

The invention in a further aspect provides a method of making an internally oxidized Ag-SnO system alloy electrical contact material, which comprises preparing an Ag alloy comprising 0.5 - 12 weight % of Sn, and 0.5 - 15 weight % of In or 0.01 - less than 1.5 weight % of Bi, the said alloy optionally including one or more metallic elements selected from 0.1 - 5 weight % of Cd, 0.1 - 2 weight % of Zn, 0.1 - 2 weight % of Sb, 0.01 - 2 weight % of Pb, and 0.1 - less than 2 weight % of In; completely internally oxidizing the alloy; and characterized by cutting the alloy so that the forwardmost area of the internal oxidation along its progressive direction in the alloy is exposed as a contact surface thereof.

The invention in a still further aspect provides a method of making an internally oxidized Ag-SnO system alloy electrical contact material, which comprises preparing an Ag alloy of a desired thickness comprising 0.5 - 12 weight % of Sn, and 0.5 - 15 weight % of In or 0.01 - less than 1.5 weight % of Bi, the said alloy optionally including one or more metallic elements selected from 0.1 - 5 weight % of Cd, 0.1 - 2 weight % of Zn, 0.1 - 2 weight % of Sb, 0.01 - 2 weight % of Pb, and 0.1 - less than 2 weight % of In, which alloy is at least twice as thick as the said desired thickness and having an expected thickness of a depletion layer to be produced in the alloy, and fixedly sandwiched between pure silver thin layers; completely internally oxidizing the alloy; and cutting the alloy horizontally in two, simultaneously removing by said cutting the depletion layer from the alloy.

It has been found by the present inventor that though internally oxidized structures of an Ag-Sn system alloy about its surface or surfaces with which oxygen contacts first and from which it penetrates into the alloy, are rough, the deeper they lie in the alloy, the finer they become. In other words, the internally oxidized structures which have been produced in the alloy at the forwardmost area along a progressive direction of internal oxidation, are fine and free from the segregation of tin oxides. They are, therefore, most suitable as contact surfaces.

It has been observed by the inventor that along with the progressive direction of internal oxidation, grain sizes of tin oxides precipitated in Ag matrices become gradually larger. Hence, the contrast between the Ag matrices and the tin oxides becomes clearer or more apparent in the progressive direction of internal oxidation, which contrast can be expressed in that the internally oxidized structure at the forwardmost area along the progressive direction of internal oxidation is most fine. The larger the size of precipitates of tin oxides, the larger is the area the Ag matrices can occupy so that lower electrical contact resistances are assured and unduly high temperature increase of contacts can accordingly be avoided. Given that a concentration of Sn throughout an alloy or from the rearmost area to the forwardmost area of internal oxidation of the alloy is constant, the forwardmost area which consists of Ag matrices and one grain (for example) of tin oxides of a certain weight % of the Ag matrices can afford to the Ag matrices larger contact surfaces, compared to the rearmost area which consists of ten grains (for example) of the same weight % in total and Ag matrices. It shall be noted also that the larger are the precipitates of tin oxides, the lesser becomes the strain to be produced in the tin oxides with the internal oxidation, so that precipitates come to have a moderate hardness which can scarcely bring about cracks of contact surfaces.

In view of the above "the forwardmost area along a progressive direction of internal oxidation" as referred to in the specification and claims can readily be ascertained microscopically by those skilled in the art. Such fine internally oxidized Ag-Sn alloy structures at the front or forwardmost area of internal oxidation appear, when the alloy is oxidized from both sides, centrally in the alloy with a depletion zone therebetween; and when the alloy is oxidized from a single side, at the bottom opposite to a surface from which oxygen penetrates into the alloy. Since the depletion zone or a zone where tin oxides are poor or mostly absent lies usually next to the forwardmost area of internal oxidation, such area which is employed in this invention as a contact surface should be free from the above zones.

Typical constituents of Ag-Sn alloys employable in this invention are those comprising Ag matrices, 0.5 -12 weight % of Sn, and 0.5 - 15 weight % of In, and those comprising Ag matrices, 3 - 12 weight % of Sn, and 0.01 - less than 1.5 weight % of Bi. Such constituents may optionally contain one or more metallic elements selected from 0.1 - 5 weight % of Cd, 0.1 - 2 weight % of Zn, 0.1 - 2 weight % of Sb, and 0.01 - 2 weight % of Pb. In the case of the above-mentioned latter constituents, 0.1 - less than 2 weight % of In may be contained. Further, they may contain less than 0.5 weight % of one or more elements of the iron family (iron, cobalt, nickel).

According to one embodiment of the invention, said Ag alloy is prepared as a flat plate or disk having a height which is at least twice a desired final height and additionally comprises a height of a depletion layer which is expected to be produced when the Ag-alloy is completely internally oxidized. Said Ag-alloy is backed at both its surfaces by thin pure Ag layers.

Then, the thus prepared Ag-alloy is completely internally oxidized in an oxygen atmosphere under pressure and at an elevated temperature.

During the internal oxidation of the Ag-alloy, the backing thin pure Ag layers work as follows.

Since the partial pressure of oxygen, which has been dissolved into silver at the elevated temperature, is comparatively low, and since the amount of oxygen which diffuses through the silver is constant at a predetermined specific temperature, and under an oxygen atmosphere of a predetermined specific pressure, the amount of oxygen which will diffuse into a metal alloy via the silver for oxidizing the former, can readily and freely be controlled. In addition to this advantage, since the oxygen in this instance is diffused into the metal alloy through the silver, and consequently at a selected direction of paths of oxygen, crystalline metallic grains oxidized and precipitated in the metal alloy are not arranged at random but can be prismatically aligned in the paths of oxygen. Since these prismatically aligned metallic oxides are also in parallel with electric current paths passing through the internally oxidized Ag alloy contact material the electrical resistance of the material is reduced.

The completely internally oxidized Ag alloy plate or disk having a depletion layer which lies centrally and transversely to the axis or height of the plate or disk, is cut along the depletion layer by a super hard and high speed cutting device such as a mill with a width greater than the width of the depletion layer. Unlike the conventional sanding off of segregation of metal oxides from outer surfaces of oxidized Ag alloys, said cutting operation does not impart any contamination to cut surfaces and a cut-off portion of the Ag alloy which includes the depletion layer.

Two parts thus cut off from the plate or disk have respectively a completely internally oxidized Ag alloy body having a fresh contact surface of a moderate hardness and initial resistance and a pure silver backing at its bottom surface, and having no depletion layer.

The invention will be further described with reference to the following illustrative Examples.

Example 1

(1) Ag-Sn 8%-In 4%

(2) Ag-Sn 8%-In 4%-Cd 0.5%

(3) Ag-Sn 7%-Bi 0.5%

(4) Ag-Sn 7%-Bi 0.5%-Zn 0.3%

The above alloys (1) to (4) were melted in a high frequency melting furnace at about 1,100 to 1,200°C and poured into molds for obtaining ingots of about 5 Kg each. Each ingot was stripped at its one surface. Then, each ingot was butted at its stripped surface to a nickel plate by means of a hydraulic press, and rolled to a plate about 2.2 mm thick with the nickel back about 1 mm thick.

Each plate was subjected to an oxygen atmosphere for 200 hours and at 650°C so that the plate was completely internally oxidized. Since the nickel back is un-oxidizable, internal oxidation progressed from the stripped surface only. Segregation of tin oxides was observed around the stripped surface. The internally oxidized structures which had been produced in the plate at the forwardmost area along the progressive direction of internal oxidation, viz. in this instance about 2 mm deep from the stripped surface, were extremely fine and completely free from the segregation of metal oxides. A depletion zone or a zone where tin oxides are mostly absent was next to said forwardmost area with a depth of about 1 mm.

Each of the internally oxidized plates were placed in a hydrogen gas atmosphere and heated at 750°C for ten minutes, so that metal oxides about the stripped surface were reduced or decomposed whereby the stripped surface could be brazed to a movable or stationary contact base.

The nickel plate can be replaced by other metals which are not oxidizable, and the reduction or decomposition of metal oxides about the stripped surface may be effected by heating in a flux or immersing it into an acid solution.

Then, the plates were horizontally cut at a plane 0.2 mm from the bottom. Also, plates were slit to obtain square electrical contacts of 5 mm sides and a thickness of 1.9 mm, having the forwardmost areas of internal oxidation along the progressive direction as contact surfaces, and the reduced or decomposed stripped surfaces as backs.

Instead of slitting the plates after the internal oxidation, they may be cut or pressed out to desired configuration before the internal oxidation.

In order to compare the above electrical contacts made in accordance with this invention, contacts were made from alloys (5) to (8) respectively corresponding to the alloys (1) to (4), i.e.

(5) Ag-Sn 8%-In 4%

(6) Ag-Sn 8%-In 45-Cd 0.5%

(7) Ag-Sn 7%-Bi 0.5%

(8) Ag-Sn 7%-Bi 0.5%-Zn 0.3%

Similarly to the alloys (1) to (4), the above alloys (5) to (8) were prepared as ingots. Then, each ingot was butted at its stripped surface to a pure silver plate by means of a hydraulic press, the platen of which was heated at about 440°C, and rolled to a plate of about 2 mm thickness, while annealing at about 600°C, at every stage of rolling achieving a 30% reduction.

Each plate was internally oxidized in an oxygen atmosphere for 200 hours and at 650°C. Then, internally oxidized plates were pressed by a punch of 6 mm diameter to obtain electrical contacts 2 mm in thickness which were backed with a thin silver layer.

The above contact samples of alloys (1) to (4) of this invention and of alloys (5) to (8) of prior known samples were determined in respect of their contact surface hardness, and of their initial contact resistance under the following conditions.

Initial contact resistance:

Contact pressure - 400g

Current - DC 6V, 1A

Table 1

Samples	Hardness (HR "F")
(1)	69 - 82
(2)	67 - 74
(3)	64 - 76
(4)	67 - 76
(5)	95 - 105
(6)	93 - 94
(7)	90 - 100
(8)	90 - 100

Table 2

Samples	Initial contact resistance (mΩ)
(1)	0.6 - 2.1
(2)	0.6 - 2.1
(3)	1.5 - 1.4
(4)	0.5 - 1.6
(5)	1.2 - 2.2
(6)	1.2 - 2.2
(7)	0.7 - 2.1
(8)	1.7 - 2.2

Thus, it is apparent from the above tables that the contact materials made in accordance with the invention have moderate hardness and lower initial contact resistance, as compared to corresponding prior-known contact materials.

Example 2

An alloy ingot of composition Ag-Sn 8%-In 4% was drawn to a wire of 5 mm diameter, from which there were prepared a number of pieces each having a body portion of 5 mm diameter and 3.3 mm length, which was integrally provided at both its sides with projections of 2.5 mm diameter and 1 mm height. Those pieces were completely internally oxidized, and then cut in two transversely to their axes by a mill with a kerf of 0.3 mm, to produce rivet-shaped contact materials each having a contact head of 5 mm diameter and 1.5 mm height with a shank of 2.5 mm diameter and 1 mm height, which were characterized by making the forwardmost areas of internal oxidation as contact surfaces. The pieces may be subjected to a hydrogen atmosphere before or after they were cut in two so that the shank is brazeable to a contact support metal as described in Example 1.

The rivet-shaped contact materials thus obtained had excellent physical and electrical characteristics, compared to corresponding conventional contact materials. It was observed that the hardness of the contact materials thus obtained was about 30% less than that of conventional contact materials, and their initial contact resistance was as much as 50% less.

Example 3

Contacts were made from alloys (9) to (12) respectively corresponding to the alloys (1) to (4), i.e.

(9) Ag-Sn 8%-In 4%
(10) Ag-Sn 8%-In 4%-Cd 0.5%
(11) Ag-Sn 7%-Bi 0.5%
(12) Ag-Sn 7%-Bi 0.5%-Zn 0.3%

The above alloys (9) to (12) were melted in a high frequency melting furnace at about 1,100 to 1,200°C and poured into molds for obtaining ingots of about 5 Kg. Each ingot was stripped at both its surfaces. Then, each ingot was butted at both its stripped surfaces to pure silver plates by means of a hydraulic press, platens of which were heated at about 400°C, and rolled to a plate of 3.1 mm thickness, while annealing at about 500°C, at every stage of rolling achieving a 30% reduction.

Each plate of one of the above alloys (9), (10), (11) and (12) had a 2.5 mm thickness and was joined at both its surfaces by a pure silver layer of 0.3 mm thickness.

Each plate was completely internally oxidized in an oxygen atmosphere for 200 hours and at 650°C. The plate had centrally a depletion layer of about 0.1 - 0.2 mm thickness. Then, the plates were horizontally cut in two by a mill with a kerf of 0.5 mm. Also, the plates were slit to obtain square electrical contacts of 5 mm sides and of a thickness of 1 mm, which were backed at one of the surfaces with a thin silver layer of 0.3 mm.

Instead of slitting the plates after the internal oxidation, they may be cut or pressed out to desired configurations before the internal oxidation.

The above contact samples of alloys (9) to (12) of this invention and of alloys (5) to (8) of prior known samples (Example 1) were determined in respect of their contact surface hardness, and of their initial contact resistance under the following conditions.

Initial contact resistance:

Contact pressure - 400g

Current - DC 6V, 1A

Table 3

Samples	Hardness (HR "F")
(9)	69 - 80
(10)	67 - 72
(11)	64 - 75
(12)	67 - 75
(5)	95 - 105
(6)	93 - 94
(7)	90 - 100
(8)	90 - 100

Table 4

Samples	Initial contact resistance (mΩ)
(9)	0.6 - 2.0
(10)	0.6 - 2.0
(11)	1.5 - 1.3
(12)	0.5 - 1.4
(5)	1.2 - 2.2
(6)	1.2 - 2.2
(7)	0.7 - 2.1
(8)	1.7 - 2.2

Thus, it is apparent from the above tables that the contact materials made in accordance with this invention have moderate hardness and lower initial contact resistance, compared to corresponding prior-known contact materials.

Though in the above examples, Ag-Sn system alloys were prepared by a melting method and then subjected to internal oxidation, they can be prepared by a powder metallurgical method preferably with subsequent forging and then be subjected to internal oxidation. It is a matter of course that internal oxidation mechanisms in the case of the latter alloys work exactly the same as in the case of the former alloys. The present invention is thus concerned with alloys produced by a powder metallurgical method as well as with alloys produced by a melting method. It shall be noted also that although the electrical contact materials obtained from the alloys (9) to (12) in Example 3 in accordance with this invention in which they were contacted with oxygen not directly but indirectly through pure silver screens, had less rough oxidation structures at their surfaces which were immediately next to the silver screens and hence came to contact first with the oxygen, compared to the internally oxidized structures around the stripped surfaces of the alloys (1) to (4) of Example 1; their forwardmost areas along the progressive direction of internal oxidation had finer structures which were clearly distinctive by microscopic observations as aforementioned.

CLAIMS

1. An internally oxidized Ag-SnO system alloy electrical contact material, obtained by the complete internal oxidation of an alloy comprising 0.5 - 12 weight % of Sn, and 0.5 - 15 weight % of In or 0.01 - less than 1.5 weight % of Bi, the said alloy optionally including one or more metallic elements selected from 0.1 - 5 weight % of Cd, 0.1 - 2 weight % of Zn, 0.1 - 2 weight % of Sb, 0.01 - 2 weight % of Pb, and 0.1 - less than 2 weight % of In, characterized by having a forwardmost area of the internal oxidation along its progressive direction made as a contact surface.

2. An electrical contact material as claimed in claim 1, characterized in that the forwardmost area has been exposed as a contact surface by cutting or shaving the alloy remote from its surface from which oxygen was diffused into the alloy for the internal oxidation so that the zone which was located adjacent to the forwardmost area and where metal oxides are mostly absent, was removed from the alloy.

3. An electrical contact material as claimed in claim 2, characterized in that the surface from which oxygen was diffused into the alloy for the internal oxidation has been subjected to a chemical reaction so that metal oxides thereabout were reduced or decomposed whereby said surface became brazeable.

4. An internally oxidized Ag-SnO system alloy electrical contact material, which comprises a contact portion of a desired thickness made from an Ag alloy comprising 0.5 - 12 weight % of Sn, and 0.5 - 15 weight % of In or 0.01 - less than 1.5 weight % of Bi, the said alloy optionally including one or more metallic elements selected from 0.1 - 5 weight % of Cd, 0.1 - 2 weight % of Zn, 0.1 - 2 weight % of Sb, 0.01 - 2 weight % of Pb, and 0.1 - less than 2 weight % of In, and which alloy is at least twice as thick as the said desired thickness and additionally has an expected thickness of a depletion layer to be produced in the alloy, has been completely internally oxidized by having it fixedly sandwiched between pure silver thin layers, and horizontally cut in two, simultaneously removing the depletion layer therefrom.

5. An electrical contact material as claimed in claim 4, characterized in that the alloy sandwiched between the pure silver layers has been slit to a desired configuration after having been internally oxidized.

6. An electrical contact material as claimed in claim 4, characterized in that the alloy sandwiched between the pure silver layers has been pressed or cut out to a desired configuration before being subjected to internal oxidation.

7. A method of making an internally oxidized Ag-SnO system alloy electrical contact material, which comprises:

preparing an Ag alloy comprising 0.5 - 12 weight % of Sn, and 0.5 - 15 weight % of In or 0.01 - less than 1.5 weight % of Bi, the said alloy optionally including one or more metallic elements selected from 0.1 - 5 weight % of Cd, 0.1 - 2 weight % of Zn, 0.1 - 2 weight % of Sb, 0.01 - 2 weight % of Pb, and 0.1 - less than 2 weight % of In;

completely internally oxidizing the alloy; and characterized by cutting the alloy so that the forwardmost area of the internal oxidation along its progressive direction in the alloy is exposed as a contact surface thereof.

8. A method of making an internally Ag-SnO system alloy electrical contact material, which comprises:

preparing an Ag alloy of a desired thickness comprising 0.5 - 12 weight % of Sn, and 0.5 - 15 weight % of In or 0.01 - less than 1.5 weight % of Bi, the said alloy optionally including one or more metallic elements selected from 0.1 - 5 weight % of Cd, 0.1 - 2 weight % of Zn, 0.1 - 2 weight % of Sb, 0.01 - 2 weight % of Pb, and 0.1 - less than 2 weight % of In, which alloy is at least twice as thick as the said desired thickness and having an expected thickness of a depletion layer to be produced in the alloy, and fixedly sandwiched between pure silver thin layers;

completely internally oxidizing the alloy; and

cutting the alloy horizontally in two, simultaneously removing by said cutting the depletion layer from the alloy.

9. A method as claimed in claim 8, characterized in that the alloy is slit to a desired configuration after the internal oxidation.

10. A method as claimed in claim 8, characterized in that the alloy is pressed or cut out to a desired configuration before the internal oxidation.

European Patent Office

EUROPEAN SEARCH REPORT

0219924
Application number

EP 86 30 3361

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int Cl 4)
Y	FR-A-2 020 895 (INOVAN-STROEBE K.G.) * Claim 1; page 3, lines 2-12 *	1	C 22 C 1/10 C 22 C 5/10 H 01 H 1/02
P,Y	DE-A-3 538 684 (CHUGAI DENKI KOGYO K.K.) * Claims 1,2,4 *	1	
A	CHEMICAL ABSTRACTS, vol. 99, no. 10, 5th September 1983, page 275, no. 75392g, Columbus, Ohio, US; & JP-A-58 64 330 (SUMITOMO ELECTRIC INDUSTRIES, LTD.) 16-04-1983 * Abstract *	1	
			TECHNICAL FIELDS SEARCHED (Int Cl 4)
A,D	US-A-4 472 211 (SHIBATA) * Claim 1 *	1	C 22 C H 01 H 1/02
A	FR-A-2 266 280 (P.R.MALLORY & CO.) * Claims 1-10 *	1	
A	US-A-3 258 829 (GWYN) * Claims 1-8 *	1	
A	GB-A-2 127 040 (CHUGAI DENKI KOGYO K.K.) * Claims 1-11 * & US-A-4 457 787 (Cat. A,D) -----	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	15-12-1986	LIPPENS M.H.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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