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ELECTRICAL CONTACT OF AN INTERNALLY OXIDIZED COMPOSITION

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This invention relates to internal oxidation of metal bodies.

An object of this invention is to provide an improved method of forming bodies of metal-metal oxide combinations.

Further objects will be apparent from the following specification and claims.

Metal-metal oxide combinations have been made heretofore by mixing powders of the metal and the metal oxide in the desired proportions, and thereafter pressing and sintering this mixture. This method cannot be depended upon to provide uniformity and consistent operating characteristics in the resultant material because of the difficulty in obtaining a uniform mixture of the powders, because of variations in the powders themselves, and because of variations in apparent density of the powder mix which may result in variations in the size and/or density of the finished compacts.

This invention provides a method of forming metal-metal oxide combinations which obviates the difficulties of the previous method as discussed above and provides metal-metal oxide combinations having uniformity and consistent operating characteristics.

The method of this invention consists essentially in utilizing a product in which the element or elements to be oxidized are contained in their elementary metallic state and oxidizing these elements without changing their distribution in the product and without affecting the other element or elements in the product, by diffusing some form of oxygen throughout the product through the application of heat, with or without ambient pressure in excess of normal or atmospheric pressure.

This invention particularly uses internal oxidation to produce a useful product, through the preparation of any metal-metal oxide combination by internal oxidation of one or more of the metals in an alloy under conditions which will not harmfully affect the remaining metal or metals, or the distribution relation of the combination components.

As an example, in illustration of the invention, the preparation of silver-cadmium oxide for electrical contact material, will be described herein.

In general, the matrix material, such as the silver, may be any metal having a high diffusion rate for oxygen without forming any stable oxides, and the dispersed material, such as the cadmium, may be any material having a high affinity for oxygen and a tendency to form stable oxides. For example, instead of silver, other metals which are not affected by oxidizing treatments at the particular temperature of oxidations may be used, such as gold and palladium and

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platinum group metals and their alloys, in combination with cadmium to produce a cadmium oxide containing body, or in combination with other metals, for example, lead, thallium, and copper, capable of being oxidized by such treatment, as desired. The oxidizing conditions of pressure, heat, and oxygen application are altered to suit the particular requirements of the metals being treated.

The material to be treated does not need to be melted in order to be oxidized. In many cases, the metal to be oxidized has a higher melting point than the matrix. The melting point of silver is 961° C. and silver is used as a matrix with metals to be oxidized dispersed therein such as thorium, melting point 1845° C. and beryllium, melting point 1284° C.

Materials composed of silver and cadmium oxide have been in use for some time. A material of 90% silver and 10% cadmium oxide has found wide usage in heavy duty contacts in aircraft relays.

Previously silver-cadmium oxide was made by pressing a silver and cadmium oxide powder mixture into compacts of predetermined size, shape, and density, sintering the pressed compacts in an oxidizing atmosphere at a temperature in the range of 700° C.–900° C. and repressing the sintered compacts to a predetermined density. This method has the disadvantages previously generally discussed herein relative to forming metal-metal oxide combinations.

In carrying out the present invention the combining of the silver and cadmium to provide the product to be internally oxidized is preferably accomplished by alloying, but may be accomplished by mixing and pressing, or mixing, pressing, and sintering.

Heat and ambient pressure are simultaneously applied to this silver-cadmium alloy or composition, with the heat sufficient to oxidize the cadmium without melting the silver, and the pressure sufficient to prevent boiling off of the cadmium. The ambient pressure is applied through a pressure medium which is itself, or which acts as a vehicle for an oxidizing agent to be diffused throughout the silver-cadmium product so that the cadmium is oxidized. The silver remains in its initial state, or is only harmlessly affected by the treatment, and the component distribution relation of the product is preserved.

The oxidizing treatment may be carried out at ordinary or atmospheric pressures. In some cases, however, it has been found advantageous to use pressures higher than atmospheric pressures. This is particularly the case if elements which would have a very high vapor pressure are oxidized. Experiments furthermore, have indicated that the oxidation process can be considerably speeded up by utilizing pressures higher than atmospheric pressures.

The oxidizing agent may be pure oxygen, atomic oxygen, air, steam, ozone, oxidizing solutions or baths of oxidizing salts.

The resulting silver-cadmium oxide material has a very uniform distribution of cadmium oxide throughout the silver body. The cadmium oxide particles are desirably smaller than those in silver-cadmium oxide made by powder metallurgy methods.

Silver-cadmium oxide contacts made by this new method have been tested in an aircraft relay under 150 amperes inductive load and found to be superior to silver-cadmium oxide contacts made by the above described powder mixing method.

Fabrication of these new method contacts has been carried out as follows:

Silver-cadmium alloy strip containing 10.87% cadmium by analysis, was heated at 750° C.–800° C. for approximately 42 hours in an atmosphere of oxygen at normal atmospheric pressure. The strip was approximately $\frac{1}{16}$'' thick x 1'' wide. The electrical conductivity of the strip increased from about 44% I. A. C. S. to 81.5% I. A. C. S. The cadmium oxide by analysis was 10.23%. Four discs approximately ¾'' in diameter were cut from the oxidized strip. These were silver brazed to relay contact blanks and machined to approximately .040'' thick.

These contacts withstood 50,000 operations in an aircraft relay under the 150 ampere inductive load test with no sticking and with considerably less electrical erosion and less transfer than that shown by material of similar composition made by powder metallurgy methods. As compared with other contact materials under similar tests, the above material showed less electrical erosion and less transfer.

Examples of how the oxidation of the cadmium may be performed are:

(1) The silver-cadmium alloy is subjected to heating at a temperature from 200° C. to a temperature just below the melting point of the alloy in an air atmosphere under normal atmospheric pressure.

(2) The silver-cadmium alloy is heated as in method 1 except in an atmosphere of oxygen.

(3) The silver-cadmium alloy is heated in a sealed pressure-tight container in an atmosphere of air, oxygen, or steam. The container is equipped with suitable valves for maintaining any desired pressure and for regulating the flow of the oxidizing medium through the container, if such a flow is desired. A temperature just below the melting point of the alloy is employed.

In using the method of Example 3 above in oxidizing cadmium in silver-cadmium, oxygen diffuses through the silver body rapidly at elevated temperatures and atmospheric pressure is normally sufficient to keep the cadmium from boiling out during the treatment.

The container is charged with silver-cadmium alloy and heated to approximately 800° C. At this temperature, pressure inside the container is about 2.5 atmospheres.

When using air as the oxidizing agent, atmospheric pressure is normally sufficient. If greater pressure is needed, compressed air may be injected into the container. If oxygen is used, the container is first evacuated and then filled with oxygen, or merely flushed out with oxygen and then closed so that pressure can be built up as desired.

Such conditions of temperature, pressure, and atmosphere as are suitable for causing complete oxidation of the cadmium throughout the cadmium-silver alloy are employed.

Discs for electrical contacts are punched from silver-cadmium oxide strip processed as above, or cut from rod so processed.

According to this invention, the oxidizable materials are completely oxidized, and, as in silver alloys, solid solution elements are removed from the silver, resulting in electrical conductivities equivalent to the silver percentages contained in the materials.

What is claimed is:

1. An electrical contactor for switches, relays, and the like, comprising a make-and-break contact consisting of a silver-cadmium oxide composition having a structure obtained by internal oxidation of a cast silver-cadmium alloy throughout the alloy, said composition being characterized by a silver matrix of coarse grain structure and by the presence of amorphous particles of cadmium oxide uniformly distributed throughout said matrix and being further characterized by a density, ultimate strength, ductility and resistance to erosion which are considerably higher than those of silver-cadmium oxide contacts of identical composition formed by powder metallurgical procedures.

2. An electrical contactor for switches, relays, and the like, comprising a metal base, and a make-and-break contact conductively bonded to said base, said contact consisting of a silver-cadmium oxide composition having a structure obtained by internal oxidation of a cast silver-cadmium alloy throughout the alloy, said composition being characterized by a silver matrix of coarse grain structure and by the presence of amorphous particles of cadmium oxide uniformly distributed throughout said matrix and being further characterized by a density, ultimate strength, ductility and resistance to erosion which are considerably higher than those of silver-cadmium oxide contacts of identical composition formed by powder metallurgical procedures.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,701,299	Engle	Feb. 5, 1929
1,720,000	Ramage	July 9, 1929
1,832,307	Kingsbury	Nov. 17, 1931
1,874,127	Schaeffer	Aug. 30, 1932
1,940,962	Matthias	Dec. 26, 1933
2,041,381	Streicher	May 19, 1936
2,145,690	Hensel	Jan. 31, 1939
2,182,381	Hensel	Dec. 5, 1939
2,187,589	Lenel	Jan. 16, 1940
2,189,755	Hensel	Feb. 13, 1940
2,396,100	Hensel	Mar. 5, 1946

FOREIGN PATENTS

Number	Country	Date
324,028	Great Britain	Jan. 10, 1930

OTHER REFERENCES

Rhines et al., "Internal Oxidation in Dilute Alloys of Silver . . ."; Amer. Inst. of Mining and Met. Engrs., vol. 147, 1942, pages 318–330 (particularly pp. 318, 319).