Patented Nov. 21, 1939 2,180,984

UNITED STATES PATENT OFFICE

2,180,984

METAL COMPOSITION

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No Drawing. Original application September 29, 1937, Serial No. 166,371. Divided and this application January 10, 1939, Serial No. 250,102

2 Claims. (Cl. 75—136)

This invention relates to the production of a metallic composition, particularly suitable for electrical contact purposes.

This application is a division of my co-pending application S. N. 166,371, filed September 29, 1937.

It is an object of this invention to provide a new material which will have a very high melting point, combined with comparatively low electrical resistivity.

It is a further object of this invention to produce a material which will not dissociate at operating temperatures, and form layers of high contact and specific resistance.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combinations of elements and arrangements of part which will be exemplified in the construction hereinafter set forth and the scope of the application of which will be indicated in the claims.

In the prior art, constructions have been mentioned in which refractory metals and their compounds were impregnated with a lower melting point metal of the nature of silver and copper plus gold, or iron, nickel and cobalt, or a metal of the platinum or palladium group. Usually the metals selected are molybdenum or tungsten or their carbides. The metals tungsten and molybdenum, which are highly refractory, have the disadvantage that they oxidize at comparatively low temperatures and certain forms of tungsten and molybdenum oxides produce very high contact resistance. As a matter of fact, they act as insulators. The carbides of these metals, which also have been tried, in many instances, have usually a very high specific resistance.

The present invention contemplates metal compositions comprising as essential ingredients thereof one or more nitrides of metals selected from the fourth and fifth groups of the periodic system, namely, titanium, zirconium, hafnium, vanadium, columbium and tantalum combined with nitrogen, a refractory metal of the tungsten-molybdenum group or their compounds and a low melting point metal selected from the group silver, copper and gold or an alloy of such metals. The metal compositions may also include substantial percentages of other refractory metals or refractory metal compounds if desired.

An important advantage arising from the use of refractory nitrides listed above resides in their relatively high electrical conductivity whereby they are rendered advantageous for electrical purposes. As an example, the electrical resistivity of two of these compounds are here listed:

Compound	Resistivity microhms/c. m.	Melting point absolute temperature
Zirconium nitride	13.6	3255
Titanium nitride	21.7	3220

It is quite remarkable that the nitrides of such metals as zirconium, hafnium and titanium show a much lower resistivity than the elements themselves. Pure zirconium, for instance, has a resistivity of 44.6 microhms c. m., while titanium has a resistivity of almost 90 microhms c. m.

Tests have shown that the carbides of the sixth group of the periodic system, particularly the carbides of molybdenum and tungsten, are easily attacked by the air at elevated temperatures. The compounds of the present invention are more resistive to an attack of oxidizing atmosphere at such elevated temperatures.

Any alloy of this nature may be employed to advantage in numerous applications but as previously stated, it is particularly desirable for electric uses such as electrical contacting elements. It may also be employed as a resistance welding die material.

I have found that metal mixtures of the following combinations are particularly desirable:

	Per cent
a. Nitrides of elements selected from the group consisting of titanium, zirconium, hafnium, vanadium, columbium, tantalum either individually or in combination	3–25
Refractory material of the tungsten-molybdenum group or their compounds, such as their carbides	25–50
Silver, copper or gold or alloys containing said element as principal ingredients	25–50
b. The nitrides of elements selected from the group consisting of titanium, zirconium, hafnium, vanadium, columbium, tantalum either individually or in combination	25–75
Metal of the nature of tungsten or molybdenum or their compounds up to	50

Silver, copper or gold or alloys containing said elements as principal ingredients	1–50
c. The nitrides of elements selected from the group consisting of titanium, zirconium, hafnium, vanadium, columbium, tantalum either individually or in combination	50–99
Metal of the nature of tungsten or molybdenum or their compounds up to	10
Silver, copper or gold or alloys containing said elements as principal ingredients	1–25

The strength and arcing characteristics of the refractory metal compounds as shown above will depend on the percentage of low melting point alloy which is added to the refractory base.

There are several methods which I may use in order to produce the desired structure; namely, a homogeneous and fine grained texture which will be more resistant to oxidation than the metal structures heretofore used and which will therefore also have a tendency to retain a low contact resistance and which will furthermore produce a material which even during heavy arcing will not tend to stick. Sticking is usually caused by the fusing together of small particles of the low melting point metal. However, by selecting the proper ratios of the refractory compounds with or without refractory metals of the nature of tungsten and molybdenum, a structure is produced which will completely separate the low melting point particles, so that in service they can not flow together if arcing occurs, and make contacts stick.

While it was necessary previously to use low percentages of refractory compounds in order to obtain a low specific resistance, with the new materials described herein, almost any percentage up to 99% of the refractory alloys may be used and still a good conductivity may be obtained without excessive over-heating.

The methods by which the above mentioned combinations are produced may vary. I may take, for instance, the powders of the refractory metal nitrides and mix them with the powders of the metals of the tungsten group and the powders of the low melting point alloys. After an intimate mixture has been obtained, the powders can be pressed, either cold or at elevated temperatures. After the pressing, the powders may be sintered, either below the melting point of the low melting point metal, or above. After the sintering operation, the material may be repressed and resintered and then swaged, rolled or forged to any desired shape or it may be used in the pressed condition.

Another possibility is to mix the powders of the refractory nitrides and the refractory metals together, with or without the addition of a metal of the iron group. After pressing and sintering, or pressing, sintering, crushing, repressing and resintering, the low melting point constituent may be introduced into this mixture by means of capillary action at temperatures above the melting point of the low temperature constituent. Repressing and resintering, with or without further operations, may also be applied in this case. In certain instances, it has been found advisable to combine the above mentioned manufacturing procedures by substituting various steps of the one procedure with certain steps of the second procedure.

There are also certain possibilities of varying the impregnation process. It may, for instance, be desirable to spray the low melting point constituent onto the pressed body of the sintered refractory material, and then heat same to absorb the sprayed-on layer of the low melting point material. Instead of spraying, other processes such as plating, may also be used.

By means of these methods, excellent metal compositions are obtained, the structure of which is homogeneous and the bodies of which may be easily prepared. Such bodies will also retain, over long periods of time, their original homogeneous structure.

Instead of using a pure nitride of the metal of the fourth or fifth group of the periodic system, I have found that I can use commercial grades of these materials which usually contain a certain percentage of impurities. As a matter of fact, in many cases, I have found it very desirable to have impurities present because they seem to improve the wetting characteristics and form a stronger union between the low melting point phases and the refractory metal compounds. Instead of using pure nitrides, therefore, I may use also, nitrides contaminated with a small percentage of carbon. Such nitrides are generally known as "cyano nitrides". Also, small quantities of the iron group metals are often present.

Since certain changes in carrying out the above processes, and certain modifications in the composition, which embody the invention, may be made, without departing from its scope, it is intended that all matter contained in the above description, shall be interpreted as illustrative and not in a limiting sense. It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention, which as a matter of language might be said to fall therebetween.

What is claimed is:

1. A metal composition consisting of 25 to 75% of at least one of the nitrides selected from the group consisting of nitrides of titanium, zirconium, hafnium, vanadium, columbium and tantalum, from the least useful amount up to 50% of a refractory material selected from the group consisting of the metals of the tungsten and molybdenum group and their refractory carbides, balance substantially all a lower melting point metal selected from the group consisting of silver, copper and gold.

2. An electric contacting element formed of a metal composition consisting of 25 to 75% of at least one of the refractory nitrides selected from the group consisting of the nitrides of titanium, zirconium, hafnium, vanadium, columbium and tantalum, from the least useful amount up to 50% of a refractory material selected from the group consisting of the metals of the tungsten and molybdenum group and their refractory carbides, balance substantially all a lower melting point metal selected from the group consisting of silver, copper and gold.

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