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COMPOSITION OF MATTER COMPRISING HARD MATERIALS

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5 Claims

ABSTRACT OF THE DISCLOSURE

A sintered composition of matter consisting essentially of hard materials; at least 0.1% by weight of said hard materials being in the form of filament-like monocrystals which generally have a diameter of 1–4 microns and a length of 20–40 microns. The hard materials consist essentially of carbides, borides and/or nitrides of elements selected from the group of tungsten, tantalum, titanium and niobium and bonding material selected from the group of iron, cobalt and nickel. The aforementioned materials are ground and mixed. The ground mixtures is then pressed to obtain the desired body shape and is subsequently sintered.

This application is a continuation-in-part of our U.S. application Ser. No. 509,200, now abandoned, filed Nov. 22, 1965.

When it is desired to produce sintered hard metal products, it is usual to grind a starting mixture. The ground mixture is then pressed to obtain the desired shaped bodies, which are subsequently sintered. The starting mixture comprises hard materials, for instance carbides, nitrides and borides of the metals tungsten, titanium, columbium and tantalum, and a bonding metal, such as cobalt, iron or nickel.

Such hard metal products may be required to meet highly different requirements as to toughness and wear resistance. For this reason, the properties of the hard metal products must be selected in view of their intended purpose. This may be effected by a suitable selection of the hard materials which are employed, also by the nature and mainly by the amount of the bonding metal, and by the selection of the particle size composition. As a high toughness and high wear resistance are mutually inconsistent, the optimum combination of these two properties must be determined in each case. It would be desirable to increase the wear resistance without a substantial reduction in toughness.

According to the invention, sintered hard metal products having a greatly increased wear resistance are obtained by using a relatively small proportion of a hard material in the form of filament-like monocrystals known as "whiskers." Such monocrystals have a very high hardness so that they are extremely effective even in relatively small quantities in increasing the wear resistance. Additions of an order of about 0.1% result in a substantial increase in wear resistance.

Filament-like tungsten monocrystals, for instance, have been found in small amounts up to about 0.01% in some tungsten metal powders. These monocrystals have in most cases a diameter of 1–4 microns and a length of 20–40 microns. The carburization of such tungsten powders at about 1600° C. in order to form carbides may result in the formation of tungsten carbide monocrystals which are suitable for the purpose according to the invention.

Tungsten carbide monocrystals may also be formed directly under certain carburizing conditions. This phenomenon is, for example, described in the magazine entitled Die Naturwissenschaften, volume 3, page 55, 1965, and Radex-Rundschau, pages 601 and 602, volume 4, 1965, published by Oesterreichisch-Amerikanisch Magnesit Aktiengesellschaft, Radenthein, Kaerten. The amounts in which such monocrystals are present in the usual powders are too small for an influence on the wearing properties.

To produce the sintered hard metal products according to the invention, the content of said hard material monocrystals must be increased. This is most simply effected by an addition of said monocrystals in sufficiently large amounts to the starting mixture before the same is ground.

Suitable monocrystals of hard materials are, e.g., monocrystals of tungsten carbide, nitride or boride which have been separated from tungsten metal powders or tungsten carbide, nitride or boride powders. Hard material monocrystals which are of different type, for instance the carbides, nitrides and borides of the elements titanium, tantalum or niobium, and which have been obtained by different methods are also suitable, of course, for the manufacture of sintered hard metal products according to the invention.

The proportion of filamentary single crystals should be at least 0.1%, preferably 0.5% to about 1.5%, based on the total weight of the cermet composition. The upper limit for the content of filamentary single crystals will be reached when the fines of cermet composition consist entirely of whiskers. In this connection, the fines consist of all whiskers having a mean diameter under 2 microns.

The use of composite materials which are stressed in the direction of one axis and are reinforced with whiskers to obtain high tensile strengths has already been recommended. Thus are for instance materials known which contain filament silicon carbide-monocrystals for reinforcement.

Silicon carbide however will be not used with metals of the iron group and is not suitable for the production of hard metals which are made of an admixture of carbide power and iron, cobalt and/or nickel as binding metal and which are the subject of the proposed invention.

The removery of filament-like monocrystals, also referred to as "whiskers," is known per se and not a subject matter of the present invention.

Examples of the invention will now be described.

EXAMPLE 1

An alloy is prepared which consists of 80% cobalt, 7% titanium carbide, 3% tantalum carbide, balance tungsten carbide, 0.4% of the tungsten carbide content of this alloy, based on the weight thereof, consists of filament-like monocrystals of tungsten carbide. The inclusion of these filamentlike monocrystals increases the wear resistance of such alloys by 40% whereas the hardness remains virtually unchanged.

EXAMPLE 2

An alloy is prepared which consists of 79.5% tungsten carbide, 5.5% tantalum carbide, 5.5% titanium carbide, 9.5% cobtalt, 1.0% of the tungsten carbide content of this alloy, based on the weight of said tungsten carbide, consists of filamentlike monocrystals of tungsten carbide. Compared to alloys which contain no filament-like monocrystals, the wear resistance of this alloy is increased by 35% whereas the Vickers hardness number remains the same.

EXAMPLE 3

An alloy is prepared which consists of 25% cobalt and 75% tungsten carbide. This tungsten carbide consists only of filamentlike monocrystals. This alloy has an extremely high toughness and is particularly suitable for use as cutting tool tips. The increased toughness results in an increase in bending strength by 40%. The increase in wear resistance is about 38%.

EXAMPLE 4

An alloy is prepared which consists of 74% tungsten carbide, 5% tantalum carbide, 11% titanium carbide and 10% cobalt. 2.4% of the tungsten carbide content of this alloy, based on the weight of said tungsten carbide, consist of filamentlike monocrystals of tungsten carbide. 0.8% of the tantalum carbide content of this alloy, based on the weight of said tantalum carbide, consists of filamentlike monocrystals of tantalum carbide. 1.9% of the titanium carbide content of this alloy, based on the weight of said titanium carbide, consist of filament monocrystals of titanium carbide. These filamentlike monocrystals increase the toughness, expressed by the ultimate bending load, by 40% and increase the Vickers hardness numbers by 5–20%.

EXAMPLE 5

An alloy is prepared which consists of 56% tungsten boride, 10% tantalum boride, 4% titanium boride, 9% niobium boride and 21% nickel. 0.9% of the tungsten boride content of this alloy, based on the weight of said tungsten boride consist of filamentlike monocrystals of tungsten boride. 1.5% of the tantalum boride content of this alloy, based on the weight of said tantalum boride consist of filamentlike monocrystals of tantalum boride. 1.1% of the titanium boride of this alloy, based on the weight of said titanium boride, consist of filamentlike monocrystals of titanium boride. 1.3% of the niobium boride of this alloy, based on the weight of said niobium boride consist of filamentlike monocrystals of niobium boride. These filamentlike monocrystals increase the toughness, expressed by the ultimate bending load, by 36% and increase the Vickers hardness number by 3–15%.

EXAMPLE 6

An alloy is prepared which consists of 30% tungsten nitride, 18% tantalum nitride, 25% titanium nitride, 8% niobium nitride and 19% iron. 1.5% of the tungsten nitride, based on the weight of said tungsten nitride, consist of filamentlike monocrystals of tungsten nitride. 0.8% of the tantalum nitride, based on the weight of said tantalum nitride, consist of filamentlike monocrystals of tantalum nitride. 1.3% of the titanium nitride, based on the weight of said titanium nitride, consist of filamentlike monocrystals of titanium nitride. 1.3% of the niobium nitride, based on the weight of said niobium nitride, consist of filamentlike monocrystals of niobium nitride. These filamentlike monocrystals increase the toughness, expressed by the ultimate bending load, by 32% and increase the hardness by 4–15%.

EXAMPLE 7

An alloy is prepared, which consists of a 45% tungsten carbide, 10% niobium carbide, 10% iron, 12% nickel and 23% cobalt. 1.7% of the tungsten carbide, based on the weight of said tungsten carbide consist of filamentlike monocrystals of tungsten carbide. 1.5% of the niobium carbide, based on the weight of said niobium carbide, consist of filamentlike monocrystals of niobium carbide. These filamentlike monocrystals increase the toughness, expressed by the ultimate bending load by 35% and increase the hardness by 6–20%.

What is claimed is:

1. A sintered composite consisting essentially of first materials selected from the group of carbides of elements selected from the group of tungsten, tantalum, titanium and niobium; and a second bonding material selected from the group of iron, cobalt and nickel; at least 0.1% by weight of said first materials being in the form of filament-like monocrystals.

2. The sintered composite as set forth in claim 1, wherein in said composition there are 0.5–1.5% by weight of said first materials in the form of filament-like monocrystals.

3. The sintered composite as set forth in claim 1, wherein said first materials are present in the form of fine and coarse particles, said fine particles consisting essentially of filament-like monocrystals.

4. The sintered composite as set forth in claim 2, wherein said filament-like monocrystals consist essentially of tungsten carbide.

5. A process for producing a sintered composite, which comprises the step of mixing powders of hard materials and a bonding metal; said hard materials being selected from the group of carbide elements selected from the group of tungsten, tantalum, titanium and niobium, said hard materials including at least 0.1% by weight of said composite in the form of filament-like monocrystals; said bonding metal being selected from the group of iron, cobalt and nickel; grinding the mixture, and thereafter sintering the ground mixture.

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