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METALLIC ABRASIVE COMPOSITION OF MATTER

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This invention relates to abrasive compositions of matter and more particularly to abrasive and cutting tools comprised of a metallic body containing small particle sized diamonds or other abrasive material dispersed therethrough, and has for its object the provision of an improved metallic composition for use in said metallic body.

Another object is to provide a tough, strong and substantially rust-resistant metallic composition suitable for use as the metallic body of said abrasive composition of matter.

Another object is to provide a sinterable mixture of metallic powders which on heat-treating to elevated temperatures without compaction, sinters or coalesces into a relatively dense, substantially non-porous, metal body without excessive shrinkage and which in the heat-treated condition is characterized by high strength and ductility, resistance to corrosion and to surface oxidation, and by the surface characteristic of slipperiness.

Still another object is to provide an improved metallic abrasive composition of matter consisting of a sintered mixture of metal powders and small sized diamond fragments characterized by having the diamond particles tenaciously retained in dispersed position throughout the metallic body and by having a relatively dense, tough and strong metallic body possessing the properties of rust resistance and surface slipperiness.

Other objects will be apparent as the invention is more fully hereinafter disclosed.

In co-pending application Serial No. 488,566, filed May 26, 1943, which application is assigned to the same assignee as the present application, there is described and claimed an abrasive composition comprised of diamond fragments dispersed throughout a metallic matrix and method of forming same which consists essentially in surfacing the diamond fragments with a firmly adherent but relatively thin film layer of a metal of the platinum group (specifically rhodium), mixing the coated diamonds with finely divided metal powder consisting of an iron-carbon alloy containing approximately .87% carbon, molding the mixture to the desired shape, and heat-treating the molded mixture to a temperature above 725° C. but below 800° C. for an extended time interval adapted to convert the iron-carbon alloy particles into austenite and to cement the same together and to form an intermetallic bond between the rhodium surface on the diamonds and the cemented iron-carbon alloy.

In the manufacture of abrasive compositions of the type disclosed and claimed in said co-pending application, considerable difficulty is experienced in obtaining consistently uniform sized products due to the shrinkage of the molded mixture. This shrinkage may in part be overcome by the use of pressure in the molding mixture. However, due to the hardness of the iron-carbon particles, the amount of pressure utilizable is limited to that perforating the relatively thin film of rhodium surfacing the diamond particles.

I have discovered that by the addition of one of the metals Mn and Ni, in finely divided powder form, to the iron-carbon alloy in an amount within the range 3 to 10% but preferably about 5%, the shrinkage characteristic of the molded mixture is of such a low order that the application of pressure to the molded mixture can be substantially eliminated, without at the same time detrimentally affecting the desired density. Moreover, I have found that Mn and Ni additions within the range specified, materially improve the strength and ductility of the sintered product.

In addition to the above-mentioned discovery, I have discovered also that additions of small amounts of at least one of the metals Cu, Au and Ag, together with small fractional percentages of indium, impart to the sintered mixture of iron-carbon alloy and Mn or Ni, increased density and a high resistance to corrosion and to surface oxidation or rusting together with a surface physical characteristic known in the art as "slipperiness" which markedly improve the utility of the sintered metal product.

Preferably, the amount of the metals of the group consisting of the metals Cu, Au and Ag, incorporated in the alloy, is maintained as low as practical to obtain the desired result of rust resistance. In most cases I have found that from .20 to .30% of these metals is adequate for this purpose, although larger amounts up to 1% do not appear detrimental.

In most cases, also, I have found that mixtures of the metals Cu, Au, and Ag, are somewhat more effective than the individual metals, insofar as imparting rust-resistance to the alloy is concerned. Gold and silver in approximately equal percentages and in total amount approximating .20% have been found to be exceedingly effective in imparting rust-resisting properties to sintered iron-carbon alloys (C .87%) that contain approximately 5% Mn. Cu, when used alone, must be used in somewhat larger amounts to obtain equivalent results, for example, about .35% Cu, whereas gold and silver when used alone appear about equally effective in amounts approximating .25%. Mixtures of Cu with Au and Ag, for ex-

ample 50–50 mixtures of each constituent, are slightly less effective than gold or silver or 50–50 mixtures of gold and silver.

The addition of indium to the mixture is primarily for the purpose of imparting the property of surface slipperiness to the sintered metal body. In amounts as low as .10% indium, this characteristic is exceedingly pronounced where the amount of the Cu, Au and Ag is held to the minimum percentage required to impart rust-resistance to the sintered product. As the metal, indium, is expensive it is advantageous to employ as small a percentage as possible to produce this desired result.

Surface slipperiness of the sintered metal product is highly desirable for the primary reason that such property prevents the accumulation of the abrasion-removed particles of matter in the interstices between the projecting diamond particles. This materially extends the abrading life of the abrasion surface of the abrasive composition of matter of the present invention.

In addition to imparting the property of surface slipperiness to the alloy composition of the present invention, indium also imparts hardness to the metals Cu, Au and Ag, thereby serving to toughen and strengthen the sintered metallic composition.

It is believed apparent that many different ratios of the metals Cu, Au and Ag to the metal In would be effective for the purposes of the present invention, but it is preferred to maintain the total amount of these metals as low as possible in the base mixture of iron and Mn or Ni metal powders.

As one specific embodiment of the present invention, but not as a limitation thereof, the preferred mixture of metal powders consists of. 10% Au, .10% Ag, .10% In, 5% Mn and the remainder carbonyl iron powder having a carbon content approximating .87%. The particle size of the carbonyl iron powder is, preferably, extremely small and should contain no particles larger than about 400 mesh. The particle size of the Mn may be considerably larger than this, but preferably should be less than about 200 mesh. The particle size of the Au, Ag and In should be as small as possible and should at least pass 200 to 300 mesh, in order to facilitate the substantially uniform dispersion of the same throughout the iron metal powder.

This mixture of metal powders, after thorough mixing, for example, in a ball mill for an extended time interval, is then mixed with the rhodium-surfaced diamond fragments, in the desired relative amounts which varies somewhat with respect to the particle size of the diamonds. The diamond-metal powder mixture thus obtained after being disposed in a mold with slight tamping or compaction sufficient to eliminate any large voids and to level off the material in the mold, may then be heated, under substantially non-oxidizing conditions on a slowly rising temperature gradient to a temperature approximating 750° C. for an extended time interval to sinter the same to a coherent metallic body, care being taken during the early stages of heating to heat quite slowly to drive off any moisture and surface adsorbed gases from the metal powders before sintering.

One of the major advantages of the present metallic composition over the iron-carbon alloy of the said co-pending application, lies in the fact that because of the relatively low shrinkage constant of the present composition and relatively high strength and ductility of the same, the amount of diamond fragments incorporated in the mixture may be materially increased, thereby obtaining more diamond fragments per unit surface area than heretofore obtainable.

As an example, where diamond fragments having a particle size passing 100 mesh, but not passing 120 mesh, are employed, the ratio of diamonds to metal powder may be as low as 1 to 3 whereas with the iron-carbon alloy alone a ratio of 1 to 10 is about as low a ratio as may be used. This results in a cutting or abrading surface of greatly increased efficiency.

In the above specific example, nickel may be substituted in part or in whole for the manganese. In general, nickel is more effective than manganese and may be used in lesser amounts. For example 2 to 3% Ni appears to be equivalent to 5% Mn. Preferably, carbonyl nickel powder is employed.

In the above specific example, the metals gold and silver may be displaced by .25% of either gold or silver or .35% Cu or with about .30% of a 50–50 mixture of either Cu and Au or Cu and Ag without essential departure from the invention. Also, indium in amounts greater than .10% and up to .30% may be employed without departure.

Following sintering, I prefer to quench the sintered metal product in cold water to harden the same and to prevent oxidation of the protruding edges of the diamond fragments.

As an illustration of the non-shrinking properties of the metal composition of the present invention various tests have shown that the shrinkage of the metal composition of the specific example given approximates 2% when no compacting pressure is applied to the metal powder in the mold prior to heat-treating. This low shrinkage property inhibits or protects the diamond fragments against cleavage fracture. The tenacity with which the diamond fragments are retained in embedded position in the metal body subsequently even at quite elevated temperatures, indicates also that the sintered alloy composition of the present invention has a relatively low coefficient of expansion.

To facilitate the removal of the sintered metallic body from the mold after sintering, the interior surface of the mold is covered with refractory material such as silica dust, graphite, aluminum oxide, and the like.

It is believed apparent from the above disclosure that the present invention may be widely modified without essential departure from the same and all such modifications and adaptations are contemplated as may fall without the scope of the following claims.

What I claim is:

1. In an abrasive composition of matter consisting of a metallic base member containing particles of an abrasive dispersed therethrough, a metallic base member comprised of a metallic composition consisting of a sintered mixture of metal powders, said mixture consisting of a fractional percentage of at least one of the metals consisting of the group Cu, Au and Ag, a small fractional percentage of indium, from 3 to 10% of at least one of the metals Mn and Ni, balance iron containing the eutectoid percentage of carbon.

2. In an abrasive composition of matter consisting of a metallic base member containing diamond fragments dispersed therethrough, a metallic base member comprised of a metallic composition consisting of a sintered mixture of metal

powders said mixture consisting of from .20 to .30%, at least one of the metals of the group consisting of Cu, Au and Ag, a small fractional percentage of indium, from 3 to 10% of at least one of the metals Mn and Ni, balance Fe containing about .87% C.

3. In an abrasive composition of matter consisting of a metallic base member containing diamond fragments dispersed therethrough, a metallic base member comprised of a metallic composition consisting of a sintered mixture of metal powders, said mixture consisting of about .20% Au and Ag in approximately equal amounts, .10% indium, 5.0% Mn, balance Fe containing about .87% C.

4. An abrasive composition of matter consisting of a metallic body having small sized diamond particles dispersed therethrough, said metallic body being comprised of a sintered mixture of metal powders consisting of at least one of the metals of the group Cu, Au and Ag in a fractional percentage above about .20%, a small fractional percentage of indium above about .10%, from 3 to 10% one of the metals Mn and Ni, balance Fe containing the eutectoid percentage of carbon.

5. An abrasive composition of matter consisting of a metallic body having small sized diamond particles dispersed therethrough, said metallic body being comprised of a sintered mixture of metal powders consisting of .20 to .30% Au and Ag, .10% indium, 3 to 10% Mn, balance Fe containing about .87% C.

6. An abrasive composition of matter consisting of a metallic body having small sized diamond particles dispersed therethrough, said metallic body being comprised of a sintered mixture of metal powders consisting of .20 to .30% Au and Ag, .10% indium, 5% Mn, balance Fe containing about .87% C.

7. The method of forming an abrasive composition of matter consisting of a mixture of small sized diamond fragments and metal powders sintered together which comprises forming a mixture of metal powder consisting of .20 to .30% at least one of the metals Cu, Au and Ag, about .10% indium, from 3.0 to 10.0% one of the metals Mn and Ni, balance carbonyl iron powder containing the eutectoid percentage of carbon having a particle size passing about 400 mesh, the particle sizes of the other said metals being small passing at least about 200 mesh, incorporating in said mixture the desired percentage of said diamond fragments, disposing the mixture in a mold to shape the same, heat-treating the mixture on a slowly rising temperature gradient to elevated temperatures approximating 750° C. in a substantially non-oxidizing atmosphere for an extended time interval, and quenching the heat-treated product to rapidly cool the same to atmospheric temperatures.

8. The method of forming an abrasive composition of matter consisting of diamond particles dispersed throughout a metallic matrix which comprises forming a mixture of metal powders consisting of .20 to .30% at least one of the metals Cu, Au, Ag, about .10% indium, from 3 to 10% one of the metals Mn and Ni, balance carbonyl iron powder containing the eutectoid percentage of carbon having a particle size passing about 400 mesh, the particle sizes of the other said metals passing at least about 200 mesh, incorporating in said mixture in the desired amount sized diamond particles surfaced with a firmly adherent relatively thin film of a platinum group metal, disposing the said mixture in a mold to shape the same, heat-treating the mixture on a slowly rising temperature gradient to elevated temperatures approximating 750° C. in a substantially non-oxidizing atmosphere for an extended time interval, and quenching the heat-treated product to rapidly cool the same to atmospheric temperatures.

9. The method of forming an abrasive composition of matter consisting of sized diamond particles approximating 120 mesh dispersed throughout a metallic matrix which comprises surfacing the said diamond particles with a firmly adherent relatively thin film coating of a platinum group metal, forming a mixture of metal powders consisting of .20 to .30% a mixture of about equal amounts of gold and silver, .10% indium, about 5% Mn, balance carbonyl iron powder containing about the eutectoid percentage of carbon, the particle size of the said iron powder being below about 400 mesh and the particle sizes of the other said metals not being greater than about 200 mesh, mixing the said diamond fragments and metal powder mixture together in the relative proportions of 20% and 30% respectively, disposing the mixture in a mold to shape the same, heating the said mixture on a slowly rising temperature gradient to elevated temperatures approximating 750° C. for a time interval adapted to sinter the mixture together into a coherent metallic body, and quenching the said body to rapidly cool the same to atmospheric temperatures.

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