SINTERED PRODUCT CONSISTING OF AN ALUMINIUM OXIDE LATTICE AND A METALLIC COMPONENT FILLING THE INTERSTICES OF THE LATTICE

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The present invention relates to sintered metallic products which are highly resistant to very high temperatures and mechanical stresses, and whose major portion consists of a continuous phase or lattice of aluminum oxide with a metallic component filling the interstices of the aluminum oxide lattice.

Sintered aluminum oxide products are known but the efforts to increase their stability under varying temperatures by adding certain metal components thereto have not met with complete success because no metallic component has been found to adhere satisfactorily to the aluminum oxide lattice when added in relatively small amounts in powdered form. The reason seems to have been that the metals in question do not have sufficient adhesion to aluminum oxide, their boundary or wetting angle being too large. Accordingly, a metallic component will produce a technically valuable sintered material only if the metal component is so small that the coherence of the aluminum oxide lattice, which is the basis for the heat resistance of the material, is not substantially influenced thereby.

Such ductile metals as the metals of the iron and copper group have such a large boundary angle in relation to aluminum oxide that they do not adhere thereto satisfactorily so that these metals, when admixed to aluminum oxide powder, frequently emerge from the sintered body in the form of molten globules under the high temperatures required to sinter the aluminum oxide lattice.

It is a primary object of the present invention to find a metallic filler component for a sintered aluminum oxide product, which has a low wetting angle in relation to aluminum oxide and, therefore, adheres strongly to the aluminum oxide lattice.

The above and other objects are accomplished by using a metallic component of chromium carbon alloy containing from 1% to 16%, by weight, of carbon, preferably from 1% to 9%. The major portion of the sintered product consists of aluminum oxide, the minimum percentage, by weight, being at least about 60% and the maximum percentage preferably not exceeding 95%.

I have found it particularly advantageous to use an auxiliary metallic component in addition to the chromium carbon alloy, the auxiliary component being selected from the iron group, i.e., iron, cobalt and nickel, and being added to the aluminum oxide in an amount smaller than the amount of the chromium carbon alloy component. The preferred range of the chromium carbon alloy component in the sintered aluminum oxide product is between 40%, by weight, and 3% while the preferred range of the iron group component will preferably vary between about 2% by weight, and 15%.

Corundum (aluminum oxide) powder of the desired particle size, for instance between about 0.1 μ and 5 μ, is mixed with a minor portion of a chromium carbon alloy powder of the indicated composition, which may or may not contain a metal powder of the iron group, the particle sizes of the last-mentioned metallic components varying, for instance, between 0.1 μ and 5 μ. The mixture is then shaped and sintered in a conventional manner to obtain the desired sintered product.

Chromium-carbon alloys, particularly when the carbon is present therein primarily in a carbide linkage, wet corundum very well and, therefore, adhere strongly to the corundum matrix of the product. Furthermore, they are relatively good heat and electrical conductors, giving the refractory product great stability under varying temperatures.

The melting point of the chromium carbon alloys lies in the range of about 1500° C. and 1900° C., thus encompassing the sintering temperature range of aluminum oxide. The preferred alloys, containing 1% to 9% carbon, have a melting point not exceeding about 1700° C. Such alloys will melt at a sintering temperature in excess of 1700° C., which causes a particularly good distribution of the chromium carbon alloy in the corundum matrix.

We have found that the advantages of the chromium carbon alloy addition and, more particularly, its excellent wetting ability are not impaired if a metal of the iron group is added to the mixture to increase the ductility of the final product. The amount of the ductile metal component must be smaller, however, than the amount of chromium carbide.

For instance, a mixture of chromium carbon alloy, nickel and corundum powder may be ground to a fine powder, compacted to assume a desired shape and sintered in a conventional manner to obtain a sintered corundum body having a chromium carbide-nickel phase finely distributed throughout the corundum matrix.

Unexpectedly, we have found that when we mixed 10%, by weight, of a chromium carbon alloy containing 11% carbon with 5%, by weight, of nickel and 85%, by weight, of aluminum oxide, and sintered the powder mixture at a temperature of about 1850° C., a body of good electrical conductivity throughout its entire cross section was produced. This proved that, despite the relatively small amount thereof, the chromium carbide-nickel phase formed a continuous lattice of its own which completely permeated the entire sintered body. In this manner, there was produced a refractory sintered material with the desired even distribution of metallic components throughout the matrix of the material to obtain desirable characteristics such as stability under temperature changes, conductivity and ductility.

The nickel addition was replaced partially or completely by iron and/or cobalt without substantial changes in the results.

Sintering must be effected in an oxygen-free atmosphere, for instance in a high vacuum, in an atmosphere of a noble gas or other gas mixtures free of oxygen.

While the exact composition of the products and the carbon content of the chromium carbon alloys may vary within wide limits within the indicated ranges, the following specific example will illustrate the invention without in any way limiting it thereto:

85%, by weight, of corundum powder having a particle size of 2 μ was mixed with 15%, by weight, of a chromium carbon alloy powder containing 12% carbon and having a particle size of 1 μ. The two components were finely comminuted in a ball mill where they were mixed under benzene for 75 hours. After evaporating the volatile mixing liquid, the pulverulent mixture was compacted and shaped in a conventional die, whereupon the shaped compact was sintered for an hour at a temperature of 1850° C. In a high vacuum.

The sintered product consists of a corundum lattice which has chromium carbon alloy distributed between the corundum crystals. Neither the hardness nor the mechanical resistance of the corundum body was substantially influenced by the addition which imparted great
stability to the body under varying temperature conditions.

Corundum products of this type are useful wherever refractory bodies and instruments are needed, such products also having a high resistance to mechanical stress so that they may be used for cutting or shearing tools. Since they have good heat and electrical conductivity, they may also be used for sintered products requiring the latter characteristics. They will also find use, for instance, as material for the manufacture of turbine vanes, jet nozzles and machine parts of all types, which are subjected to abrasion.

While the invention has been described in connection with certain preferred embodiments thereof, it will be understood that many variations and modifications may occur to the skilled in the art without departing from the spirit and scope thereof, as defined in the appended claims.

We claim:

1. A refractory and abrasion resistant sintered product consisting essentially of at least about 60%, by weight, of aluminum oxide constituting a continuous lattice and at least 3 percent of a chromium carbon alloy, said alloy containing from 1% to 16%, by weight, of carbon and filling the interstices of the lattice, essentially all the carbon being present in a carbide linkage.

2. The sintered product of claim 1, wherein the chromium carbide contains up to 9% of carbon in a carbide linkage.

3. The sintered product of claim 1, further comprising at least one metal selected from the group consisting of iron, nickel and cobalt, the amount of said metal being less than the amount of the chromium carbon alloy.

4. A refractory and abrasion resistant sintered product consisting essentially of at least about 60%, by weight, of aluminum oxide constituting a continuous lattice, and a metallic component filling the interstices of the lattice, said component consisting of a chromium carbon alloy containing from 1% to 16%, by weight, of carbon, essentially all the carbon being present in a carbide linkage, and of at least one metal selected from the group consisting of iron, cobalt and nickel, the chromium carbon alloy being from about 3% to 38%, by weight, of the product and the metal being from about 2% to 15%, by weight, of the product.

5. The sintered product of claim 4, wherein the chromium carbide contains up to 9% of carbon in a carbide linkage.

6. A refractory and abrasion resistant sintered product containing at least three percent by weight of a chromium carbon alloy, said alloy containing one percent to sixteen percent carbon by weight, the remainder of said product being essentially aluminum oxide, said product containing at least sixty percent of said aluminum oxide.

7. A refractory and abrasion resistant sintered product containing three to thirty-eight percent by weight of a chromium carbon alloy, said alloy containing one percent to sixteen percent carbon by weight; two percent to fifteen percent by weight of at least one metal selected from the group consisting of iron, cobalt, and nickel; the remainder of said product being essentially aluminum oxide, said product containing at least sixty percent of said aluminum oxide.

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