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CERMETS WITH HIGH IMPACT STRENGTH

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This invention relates to cermets having improved impact strength.

Cermets, also referred to as metal ceramics or ceramals, are generally composed of relatively high-melting point metals such as tungsten, chromium, cobalt, nickel, iron, zirconium or molybdenum, in combination with carbides, nitrides, borides, silicides, and oxides; such combinations result in materials having superior strength, high resistance to creep and oxidation at elevated temperatures, and good resistance to thermal shock. Thus, cermets are useful for protective coatings of heating elements, thermocouple protection tubes, high temperature and abrasion-resistant parts, etc. However, extension of this material to more critical uses such as jet turbine blades and buckets is severely handicapped due to the lack of ductility and low impact strength at room temperature of such material.

It is the primary object of this invention to provide a cermet with improved impact strength and a method for making such a material.

The present invention is based upon the discovery that the addition of low-melting metals, alloys, and/or mixtures of metals and alloys in minor percentages to a chromium-alumina cermet, to be described subsequently, results in a metal-ceramic material having superior resistance to impact.

The chromium-alumina cermets described in U.S. Patent Nos. 2,698,990 and 2,656,596, and the modifications of these with molybdenum, titanium, and tantalum pentoxide, have excellent high temperature properties; a composition comprising 16% to 36% by weight of alumina and 84% to 64% by weight of chromium metal is particularly suitable for high temperature uses, with the composition comprising 19% to 27% weight percent alumina and 81% to 73% weight percent chromium metal being the superior range of this composition. However, in their present state, the impact strength of such cermets, as measured by the Charpy impact test, is 1 to 1.5 ft.-lbs. at room temperature. The addition of from 0.1% to 20% weight percent of the base composition of low-melting metals, alloys, and/or mixtures of these causes an increase in the Charpy impact value of 3.0 to 8.5 ft.-lbs. at room temperature. "Low-melting" here refers to a temperature lower than the sintering temperature of the base compound; for chromium-alumina cermets which are sintered at approximately 1650° C., low-melting would be approximately 1550° C. and lower. This would include metals such as copper, cobalt, nickel, iron, manganese and alloys therefrom such as stainless steel, copper-aluminum alloys and nickel-base alloys, or mixtures such as iron and molybdenum. The range comprising 2.5% to 8% weight percent of the base composition is the preferred range of low-melting metal addition.

During sintering, the low-melting addition melts are dispersed almost exclusively throughout the oxide phase, and, on cooling, solidifies between the grains of the oxide

phase. A heating period, preceding the final sintering period, at 20° to 50° C. above the melting point of the low-melting constituent, aids in the uniform dispersion of the molten metal throughout the porous body. The probable reason for the improved impact strength resulting from this invention is that the fine and evenly dispersed metal addition might act as a shock absorber between the oxide particles.

Any powder metallurgy technique may be employed in preparing the cermet item. The sintering temperature is determined by the base composition. For obvious reasons, the boiling point temperature of the low-melting metal addition must exceed the sintering temperature of the cermet.

The beneficial effect of the treatment described is shown in the following examples.

Example I

Charpy impact specimens of standard 10 x 10 x 55 mm. size were slipcast from a mixture of 74 weight percent chromium, 22 weight percent alumina, and 4 weight percent copper. The specimens were then pre-sintered at about 1100° C. for 90 minutes, thereupon continuing the sintering to full densification at 1650° C. Such samples exhibited Charpy impact values of from 3.0 to 8.5 ft.-lbs. at room temperature.

Example II

Additional specimens were produced in a similar manner from a mixture comprising 74 weight percent chromium, 22 weight percent alumina, and 4 weight percent type 302 stainless steel. A sintering period at 1500° C. for 80 minutes preceded the normal sintering of the cermet. Impact test results indicated Charpy values on the order of 4 ft.-lbs. at room temperature for these specimens.

From the above it can be readily seen that the concept of adding low-melting metals, as well as their alloys and/or mixtures, to a chromium-alumina cermet is basic, and it represents a distinct advance in the additional uses to which such material can now be put due to the marked increase in impact strength at room temperature which such practice imparts to the final product.

What is claimed is:

1. A cermet consisting essentially of a substantially uniform sintered mixture of from 16 to 36 weight percent alumina and 84 to 64 weight percent chromium metal and from 0.1 percent to 20 weight percent of the chromium-alumina base composition of copper, said alumina imparting hardness to said cermet, said chromium imparting resistance to thermal shock to said cermet and said copper imparting resistance to impact to said cermet.

2. A cermet as claimed in claim 1 wherein the amount of copper is in the range of 2.5 to 8 weight percent of the chromium-alumina cermet base composition.

3. A cermet consisting essentially of a substantially uniform sintered mixture of from 19 to 27 weight percent alumina and 81 to 73 weight percent chromium metal and from 0.1 percent to 20 weight percent of the chromium-alumina base composition of copper, said alumina imparting hardness to said cermet, said chromium imparting resistance to thermal shock to said cermet and said copper imparting resistance to impact to said cermet.

4. A cermet as claimed in claim 3 wherein the amount of copper is in the range of 2.5 to 8 weight percent of the chromium-alumina cermet base composition.

5. A process for preparing a chromium-alumina cermet having high-impact strength which comprises preparing a comminuted mixture of chromium, alumina and copper, said chromium and alumina being present in said mixture in the relative proportions of 16 to 36 weight

percent alumina and 84 to 64 percent by weight chromium metal, said copper being present in said mixture in an amount between 0.1 percent and 20 percent of the chromium-alumina cermet base composition; forming the chromium-alumina-copper mixture to a shaped article; heating said shaped article at a temperature in the range of from about 1100° C. up to about 1150° C. whereby liquid copper disperses between the grains of the oxide phase; and sintering said shaped article to full densification.

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