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(54) Title: **CERMET POWDER**

(57) **Abrégé/Abstract:**

The present invention relates to cermet powders, to a method for producing a cermet powder and to use of the cermet powders for surface coating and as thermal spraying powder. The invention further relates to a method for producing a coated component, comprising the application of a coating by thermal spraying of the cermet powder, and also to a coated component which is obtainable by the method.

### Abstract

The present invention relates to cermet powders, to a method for producing a cermet powder and to use of the cermet powders for surface coating and as thermal spraying powder. The invention further relates to a method for producing a coated component, comprising the application of a coating by thermal spraying of the cermet powder, and also to a coated component which is obtainable by the method.

**Cermet powder****Field of the invention**

5

The present invention relates to cermet powder, a process for producing a cermet powder, and also the use of the cermet powders as thermal spraying powder for surface coating. The invention further relates to a process for producing a coated component, comprising the production of a coating via thermal spraying of the cermet powder, and also a coated component which is obtainable according to the process.

Thermal spraying powders are used for producing coatings on substrates. Pulverulent particles here are introduced into a combustion or plasma flame directed onto the (mostly metallic) substrate which is to be coated. The particles here melt in the flame, entirely or to some extent, and impact the substrate, where they solidify and, in the form of solidified "splats", form the coating. Thermal spraying can produce coatings up to a layer thickness of a number of mm. A frequent application of thermal spraying powders is the production of antiwear layers. Thermal spraying powders typically involve a subgroup of cermet powders, which firstly comprise a hard material, most frequently carbides, such as tungsten carbides, chromium carbides, and molybdenum carbides, and secondly comprise a matrix composed of metals, for example cobalt, nickel, and alloys of these with chromium, or else less frequently comprise iron-containing alloys. Thermal spraying powders and spray layers produced therefrom are therefore composite materials.

Coatings – like bulk materials – have empirically determinable properties. Among these are hardness, (for example Vickers, Brinell, Rockwell and Knoop hardness), wear resistance (for example ASTM G65), cavitation resistance, and also corrosion performance in various media. Corrosion resistance is increasingly important during selection of spraying materials,

since many antiwear layers have to exhibit dependable stability under acidic conditions in chemically aggressive environments (examples being use in the oil and gas industry, paper industry, chemicals industry and food-and-drink industry, and also pharmaceutical industry, often with exclusion of oxygen). This applies by way of example to displaceable parts of valves and to piston rods, when acidic mineral oil or natural gas are conveyed in the presence of chlorides or seawater. There are also many applications in the food-and-drink industry, and also the chemicals industry, where wear and corrosion exert negative synergy and thus reduce the lifetime of antiwear coatings.

The corrosion of spray layers in acidic liquids and in the presence of chlorides takes place in accordance with the principle known to apply to cemented hard materials: the matrix alloy is attacked, and ions of the matrix metals are thus liberated. This provides access to the hard materials of the spray layer, and ablation of the spray layer takes place. When tribological wear is superposed, there is then a negative synergy from wear and corrosion. Corrosion performance is further reduced by the fact that contact corrosion can occur between the hard materials and the matrix, the matrix therefore being more susceptible to corrosion in the composite material than it would be alone. This is equally observed in cemented hard materials.

Various materials have become established as thermal spraying powders for producing spray layers for the abovementioned applications, an example being WC-CoCr 86/10/4 or WC-CoNiCr 86/9/1/4, WC-Cr<sub>3</sub>C<sub>2</sub>-Ni or Cr<sub>3</sub>C<sub>2</sub>-NiCr. A feature shared by all of the abovementioned is that they comprise Cr in the matrix, since this ensures that they are corrosion-resistant.

Another material is WC-NiMoCrFeCo 85/15, and this is obtainable commercially in the form of thermal spraying powder (Amperit® 529 from H.C. Starck GmbH, D). Its matrix is composed of an alloy similar to

Hastelloy® C. Although Hastelloy® C is used successfully in acidic media, this alloy lacks wear resistance. However, as matrix alloy in composite "spraying powder" or "spray layer" material it exhibits poorer properties.

- 5 Analogous considerations apply to the chromium carbide-NiCr(80/20) materials available on the market. Here again, the good acid resistance of NiCr 80/20 cannot be transferred to the thermal spraying powder with chromium carbides or to the spray layer produced therefrom.
- 10 Fe-based matrix alloys, for example those derived from austenitic stainless steels such as 316L, or based on FeCrAl 70/20/10 according to DE 10 2006 045 481 B3, fail in an acidic environment at low pH.

When any of the abovementioned materials in the form of compacted spray  
15 powder is exposed to hydrochloric acid, sulfuric acid, or citric acid, it exhibits weakness in at least one of these media, or weaknesses in mechanical properties.

It is therefore an object of the invention to provide a cermet powder which  
20 is suitable as thermal spray powder and which, in all three media, provides stable coatings, without serious sacrifices in the mechanical properties of wear resistance and cavitation resistance, or in stability in the presence of chloride.

25 Corrosion resistance is determined here under practical conditions in the form of emissions of the matrix metals, rather than electrochemical methods such as potentiograms, which cannot quantify service time under practical conditions.

30 Surprisingly, it has now been found that the abovementioned problems can be solved via a cermet powder comprising one or more hard materials and a specific matrix metal composition.

The present invention therefore provides a cermet powder comprising

- a) from 50 to 90% by weight of one or more hard materials and
- b) from 10 to 50% by weight of a matrix metal composition, where the data by weight are based on the total weight of the cermet powder, characterized in that the matrix metal composition comprises the following:
  - i) from 40 to 75% by weight of iron and nickel,
  - ii) from 18 to 35% by weight of chromium,
  - iii) from 3 to 20% by weight of molybdenum,
  - iv) from 0.5 to 4% by weight of copper,

where the data by weight for the metals i) to iv) are based in each case on the total weight of the matrix metal composition, and where the ratio by weight of iron to nickel is in the range from 3:1 to 1:3.

- 15 The cermet powders of the present invention have excellent suitability as thermal spray powders. These powders can be used for surface coating, in particular of metal substrates. The cermet powders of the invention can by way of example be applied here to a very wide variety of components by thermal spraying processes, such as plasma spraying or high-velocity flame spraying (HVOF) or other flame spraying processes, arc spraying, laser spraying, or application welding, for example the PTA process, the aim being to give the respective component the desired surface properties.

- 25 The cermet powders of the invention comprise one or more hard materials in an amount of from 50 to 90% by weight, preferably in an amount of from 60 to 89% by weight, in particular from 70 to 88% by weight, based in each case on the total weight of the cermet powder. The cermet powders of the invention can comprise typical hard materials. However, preference is given to metal carbides as hard material, and with particular preference these are selected from the group consisting of WC, Cr<sub>3</sub>C<sub>2</sub>, VC, TiC, B<sub>4</sub>C, TiCN, SiC, TaC, NbC, Mo<sub>2</sub>C, and mixtures of these.

Preference is in particular given to the hard materials WC and/or Cr<sub>3</sub>C<sub>2</sub>.

Another essential constituent of the cermet powders of the invention is the matrix metal composition, which is present in an amount of from 10 to 50% by weight, preferably from 11 to 40% by weight, in particular from 12 to 30% by weight, based in each case on the total weight of the cermet powder. The matrix metal composition is a determining factor for the excellent properties of the cermet powders of the invention.

The present invention therefore further provides the use of a matrix composition comprising:

- i) from 40 to 75% by weight of iron and nickel,
  - ii) from 18 to 35% by weight of chromium,
  - iii) from 3 to 20% by weight of molybdenum,
  - iv) from 0.5 to 4% by weight of copper,
- where the data by weight for the metals i) to iv) are based in each case on the total weight of the matrix metal composition, and where the ratio by weight of iron to nickel is in the range from 3:1 to 1:3, for producing a cermet powder.

In one preferred embodiment, the matrix metal composition comprises, as additional metal,

- v) cobalt, in particular in an amount of up to 10% by weight, based on the total weight of the matrix metal composition.

The matrix metal composition can moreover also comprise

- vi) modifiers, in particular selected from the group consisting of Al, Nb, Ti, Ta, V, Si, W and any desired mixtures thereof.

The usual amount present of the modifiers here is up to 5% by weight, based on the total weight of the matrix metal composition.

In one specific embodiment of the present invention, the matrix metal composition to be used in the invention consists essentially of the following components:

- i) from 40 to 75% by weight of iron and nickel,
- 5 ii) from 18 to 35% by weight of chromium,
- iii) from 3 to 20% by weight of molybdenum,
- iv) from 0.5 to 4% by weight of copper,
- v) optionally up to 10% by weight of cobalt,
- vi) optionally up to 5% by weight of one or more modifiers,
- 10 where the data by weight for the metals i) to vi) are based in each case on the total weight of the matrix metal composition, and where the ratio by weight of iron to nickel is in the range from 3:1 to 1:3.

Excellent properties can be achieved with a matrix metal composition which  
15 comprises from 15 to 50% by weight, preferably from 20 to 45% by weight, of iron.

Preference is further given to a matrix metal composition comprising from  
15 to 50% by weight, more preferably from 20 to 45% by weight, of nickel.

20 The presence of chromium, molybdenum and copper in the matrix metal composition is also essential in achieving the excellent properties of the cermet powder or of the surface coatings produced therefrom.

25 The matrix metal composition preferably comprises from 20 to 33% by weight, more preferably from 20 to 31% by weight, of chromium.

In an embodiment to which preference is further given, the matrix metal composition comprises from 4 to 15% by weight of molybdenum, in  
30 particular from 5 to 10% by weight of molybdenum.

The copper content is important, in particular also in conjunction with the specific iron-nickel ratio, in relation to the corrosion properties. Excellent

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corrosion results were achieved with a matrix metal composition comprising preferably from 0.7 to 3% by weight, in particular from 0.9 to 2.0% by weight, of copper.

- 5 The ratio by weight of iron to nickel in the matrix composition likewise contributes to the corrosion-resistance of the cermet powder of the invention.

The ratio by weight of iron to nickel in the matrix metal composition is  
10 preferably from 1:2 to 2:1, more preferably from 1:1.5 to 1.5:1.

The cermet powders of the invention are preferably used as thermal spray powders. Certain particle sizes have proven to be particularly suitable here. In one preferred embodiment, the average particle size of the cermet  
15 powders of the invention is from 10 to 100  $\mu\text{m}$ , determined by means of laser scattering according to ASTM C1070.

The present invention further provides a process for producing the cermet powder of the invention.

20

Another embodiment of the present invention therefore provides a process for producing a cermet powder comprising the following steps:

- a) mixing or milling of one or more hard-material powders with a pulverulent matrix metal composition which comprises the following:
- 25 i) from 40 to 75% by weight of iron and nickel,  
ii) from 18 to 35% by weight of chromium,  
iii) from 3 to 20% by weight of molybdenum,  
iv) from 0.5 to 4% by weight of copper,
- where the data by weight for the metals i) to iv) are based in each  
30 case on the total weight of the matrix metal composition, and where the ratio by weight of iron to nickel is in the range from 3:1 to 1:3,
- b) sintering the powder mixture and  
c) optionally pulverizing the mixture sintered in step b).

The mixing or milling in step a) of the process of the invention for producing cermet powder can by way of example take place via dispersion of the pulverulent hardness imparting materials (hard materials), and also of the pulverulent matrix metal composition, in a liquid. In the case of milling, said dispersion is then milled in a  
5 milling step, for example in a ball mill or in an attritor.

The present invention further provides use of the cermet powders as described herein for surface coating.

The present invention further provides use of the cermet powders as described herein as thermal spraying powder.

10 The present invention further provides process for producing a coated component comprising the application of a coating via thermal spraying of a powder as described herein.

The present invention further provides coated component obtained by the process as described herein.

15 In one preferred embodiment of the present invention, the matrix metal composition takes the form of alloy powder.

The process of the invention for producing cermet powder is preferably characterized in that the mixing via dispersion in a liquid, optionally followed by milling, is followed, via removal of the liquid, by a granulation step, which more preferably takes place via  
20 spray drying. The spray granulate can then be classified and, in a thermal process step that follows, can be sintered to the extent that the mechanical strength of the granulate is sufficient to restrict disintegration of the granulate during the thermal spraying process, in a manner which allows reliable conduct of the thermal spraying process. The sintering of the powder mixture preferably takes place under reduced  
25 pressure and/or in the presence of inert gases, preferably selected from the group

consisting of hydrogen, argon, nitrogen and mixtures thereof, at any desired pressure.

When an inert gas that avoids oxidation is used, the sintering can also be carried out in the approximate region of atmospheric pressure. The sintering step usually gives a powder or a loose sintered cake which can easily be converted back to powder. The powders obtained are similar in size and appearance to the spray granulate.

Agglomerated/sintered spray powders are particularly advantageous, since they offer great freedom in the selection of the components (for example their contents and particle sizes), and, by virtue of their good flowability, have good metering properties in the spraying process. In one particularly preferred

embodiment of the present invention, very fine-particle hardness-imparting materials preferably with average particle size below 20  $\mu\text{m}$ , determined by means of laser scattering according to ASTM C1070, are used for the cermet powders of the invention and for the purposes of the production process of the invention for cermet powder. The use of such fine-particle hardness-imparting materials leads to very smooth wear surfaces, and this in turn leads to low coefficients of friction and to long service times.

Sintered/crushed cermet powders or, respectively, spray powders can be produced analogously, except that the powder components are not necessarily mixed wet in dispersion, but can instead be mixed dry, and are optionally tableted or compacted to give other moldings. The sintering step that follows takes place analogously, but compact, strong sintered structures are usually obtained, which require exposure to mechanical force for conversion back to powder form. However, in these instances the resultant powders with average particle sizes from 10 to 100  $\mu\text{m}$  are typically of irregular shape and characterized by fractured surfaces. These thermal spray powders have markedly poorer flowability, and this can be disadvantageous for a constant application rate during thermal spraying, but is still practicable.

The cermet powders of the invention, or the cermet powders obtainable according to the process of the invention for producing cermet powder, can be used as thermal spray powder. The present invention therefore further provides the use, as thermal spray powder, of the cermet powders of the invention or of the cermet powders obtainable via the process of the invention for producing cermet powder.

The cermet powders of the invention moreover have excellent suitability for surface coating, in particular of metal substrates or of components.

The present invention therefore further provides the use, for surface coating purposes, of the cermet powders of the invention or of the cermet powders

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obtainable via the process of the invention for producing cermet powder. The surface coating preferably place via thermal spraying processes, for example via plasma spraying or high-velocity flame spraying or other flame spraying processes, or arc spraying, or laser spraying, or application  
5 welding.

The cermet powders of the invention or cermet powders obtainable via the process of the invention for producing cermet powder impart excellent properties to the components coated therewith, in particular in respect of  
10 protection from wear under corrosive environmental conditions, for example at pH below 7 and in the presence of any chloride ions that may be present.

The present invention therefore further provides a process for producing a coated component, comprising the application of a coating via thermal  
15 spraying of a cermet powder of the invention or of a cermet powder obtainable via the process of the invention for producing cermet powder.

The present invention further provides a coated component obtainable by the production process of the invention. The component coated in the  
20 invention is in particular used for protection from wear under corrosive environmental conditions, in particular at pH below 7 and in the presence of any chloride ions that may be present.

In another preferred embodiment, the coated component is part of an apparatus which comes into contact with media which comprise acids  
25 and/or which comprise chloride ions. By way of example, coated components of the present invention are displaceable parts of valves or are piston rods.

30 The examples below illustrate the invention, without any resultant restriction of the invention thereto.

**Example 1 (comparative example)**

Spray powders with compositions according to Table 1 were compacted for 10 min at 1000°C to give compact moldings with identical specific surface area, by means of hot pressing. The peripheral layers were smoothed by means of abrasive SiC paper. The cylindrical moldings were then exposed  
 5 for 28 days to 500 ml of the media (1N hydrochloric acid, 1N sulfuric acid, and 1N citric acid – the latter corresponding to 1/3 mol/l) at 20°C with air ingress. 180 ml were then removed, and the content of the elements of which the matrix was composed was determined.

- 10 The mechanical properties wear resistance and cavitation resistance were determined on sprayed layers. The sprayed layers were also subjected to the ASTM B117 salt-spray test, and the change was recorded after 1000 hours.
- 15 Coatings made of the spray powders were also produced on ST37 structural steel and on V4A stainless steel. A JP5000 HVOF burner was used for this purpose. The data in the table are in percent by weight.

Table 1: Prior-art spray powders

20

|                   | 1  | 2  | 3   | 4  | 5    | 6  | 7  |
|-------------------|----|----|-----|----|------|----|----|
| <b>WC (%)</b>     | 86 | -  | 73  | 85 | 85   | 70 | 85 |
| <b>Cr3C2(%)</b>   | -  | 75 | 20  | -  | -    | -  | -  |
| <b>Matrix (%)</b> | 14 | 25 | 7   | 15 | 15   | 30 | 15 |
| <b>Fe(%)</b>      | -  | -  | -   | 6  | 63.3 |    | 70 |
| <b>Co(%)</b>      | 71 | -  | -   | 5  | -    |    | -  |
| <b>Ni (%)</b>     | -  | 80 | 100 | 57 | 14   | 67 | -  |
| <b>Cr (%)</b>     | 29 | 20 | -   | 16 | 18   | 20 | 20 |
| <b>Al (%)</b>     | -  | -  | -   | -  | -    | -  | 10 |
| <b>Nb (%)</b>     | -  | -  | -   | -  | -    | 4  | -  |
| <b>Mo (%)</b>     | -  | -  | -   | 16 | 2.7  | 9  | -  |
| <b>Cu (%)</b>     | -  | -  | -   | -  | -    | -  | -  |

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|                                                                                     |       |      |      |      |       |      |      |
|-------------------------------------------------------------------------------------|-------|------|------|------|-------|------|------|
| <b>Matrix emission<br/>(mg/180 ml, 28 days, 1N HCl)</b>                             | 2283  | 5684 | 420  | 3269 | 2510  | 4360 | 3083 |
| <b>Matrix emission<br/>(mg/180 ml, 28 days, 1N<br/>H<sub>2</sub>SO<sub>4</sub>)</b> | 2366  | 5151 | 1835 | 2202 | 2620  | 2570 | 3222 |
| <b>Matrix emission<br/>(mg/180 ml, 28 days, 1N citric<br/>acid)</b>                 | 316   | 2486 | 11   | 125  | 1352  | 106  | 3141 |
| <b>Properties of sprayed layer:</b>                                                 |       |      |      |      |       |      |      |
| <b>Wear (ASTM G65-04, mg)</b>                                                       | 20    | 41   | 15   | 41   | 33    | 41   | 23   |
| <b>Cavitation wear (mg/h)<br/>according to ASTM G32 on<br/>level coating</b>        | 5     | 5    | 7    | 5    | 10    | 7    | 5    |
| <b>Change in salt-spray test<br/>according to ASTM B117<br/>(1000 h)</b>            | disc. | none | none | none | disc. | none | none |

"disc." means "discoloration".

The data by weight for "Fe(%)" to "Cu(%)" are based on the total weight of the matrix composition. The total content of matrix is stated in the "Matrix (%)

5 (%) " row, and is based on the total weight of the spray powder. The % data for the carbides are based on the total weight of the spray powder. In the spray powders of examples 4 to 7, the matrix took the form of alloy, since corresponding alloy powder was used for producing the spray powder. Example 7 corresponds to a preferred embodiment of

10 DE 10 2006 045 481 B3.

It is clear from the results that no known material performs adequately in all respects. WC-Cr<sub>3</sub>C<sub>2</sub>-Ni 83/20/7 (example 3) is the only material with adequate resistance to hydrochloric acid and citric acid – but not to sulfuric

15 acid. The resistance of all of the spray powders of example 1-7 to sulfuric acid is generally poor.

Spray powder example 4 with a matrix alloy similar to Hastelloy®C, and example 6, also have good mechanical properties and good resistance to citric acid, but are not resistant to mineral acids.

- 5 Spray powder example 5 with 316 L stainless steel has very low corrosion-resistance and exhibits unacceptable discoloration in the salt-spray test.

**Example 2 (partly inventive, where indicated by \*)**

- 10 Moldings and sprayed layers were produced by analogy with example 1. The powders according to examples 8 and 9 used 2 alloy powders of identical nominal composition but from different production processes (spraying of the alloy from the melt and cooling of the resultant melt droplets by means of water and, respectively, argon injected through a nozzle). Example 10  
15 comprises, as matrix, an FeNi 50/50 alloy powder, and also a chromium metal powder used as further component of the matrix. It can therefore be assumed that in the agglomerated/sintered spray powder the matrix was not completely and uniformly alloyed with Cr. The data in the table are in percent by weight.

20

Table 2: Spray powders

|                   | <b>8*</b> | <b>9*</b> | <b>10</b> |
|-------------------|-----------|-----------|-----------|
| <b>WC (%)</b>     | 85        | 85        | 87.5      |
| <b>Cr3C2(%)</b>   | -         | -         | -         |
| <b>Matrix (%)</b> | 15        | 15        | 12.5      |
| <b>Fe(%)</b>      | 31        | 31        | 36        |
| <b>Co(%)</b>      | -         | -         | -         |
| <b>Ni (%)</b>     | 31        | 31        | 36        |
| <b>Cr (%)</b>     | 27        | 27        | 28        |
| <b>Al (%)</b>     | -         | -         | -         |
| <b>Nb(%)</b>      | -         | -         | -         |
| <b>Mo(%)</b>      | 6.5       | 6.5       | -         |

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|                                                                                     |      |      |               |
|-------------------------------------------------------------------------------------|------|------|---------------|
| <b>Cu (%)</b>                                                                       | 1.3  | 1.3  | -             |
| <b>Matrix emission<br/>(mg/180 ml, 28 days,<br/>1N HCl)</b>                         | 216  | 151  | 1740          |
| <b>Matrix emission<br/>(mg/180 ml, 28 days,<br/>1N H<sub>2</sub>SO<sub>4</sub>)</b> | 151  | 92   | 1141          |
| <b>Matrix emission<br/>(mg/180 ml, 28 days,<br/>1N citric acid)</b>                 | 68   | 61   | 608           |
| <b>Properties of sprayed<br/>layer</b>                                              |      |      |               |
| <b>Wear (ASTM G65-04,<br/>mg)</b>                                                   | 26   | 26   | 15            |
| <b>Cavitation wear<br/>(mg/h)</b>                                                   | 6    | 5    | 8             |
| <b>Change in salt-spray<br/>test</b>                                                | none | none | discoloration |

The data by weight for "Fe(%)" to "Cu(%)" are based on the total weight of the matrix composition. The total content of matrix is stated in the "Matrix (%)" row, and is based on the total weight of the spray powder. The % data for the carbides are based on the total weight of the spray powder.

Surprisingly, the iron- and nickel-containing spray powders 8 to 10 exhibit relatively good resistance to mineral acids in comparison with those having a matrix based on nickel, on cobalt, or indeed on iron. This is surprising to the extent that iron is substantially less inert than nickel. Even the incomplete alloy of the matrix with Cr in No. 10 gives better results in sulfuric acid than any of the powders of example 1. It appears that FeNi alloys have better acid resistance than the range-endpoints Ni and Fe, and the acid resistance therefore appears to be dependent on the Fe:Ni ratio, as well as on the other elements present.

The acid resistance of the FeNi matrix is further improved in powders Nos. 8 and 9 by the chromium alloyed in the matrix here, and also by the additional materials Mo and Cu. Since, however, the high Mo contents in  
 5 powders 4 and 6 do not lead to improved acid resistance, it has to be concluded that, alongside the Fe/Ni ratio, the copper content is substantially concomitantly responsible for the good corrosion results.

### Example 3 (comparative example, pure matrix alloys)

10

Table 3: Matrix metal composition

|                                                                                     | No. 11<br>(316L) | No. 12<br>(NiCr80/20) | No. 13<br>(NiCr 50/50) |
|-------------------------------------------------------------------------------------|------------------|-----------------------|------------------------|
| <b>Fe(%)</b>                                                                        | 68               | -                     | -                      |
| <b>Co(%)</b>                                                                        | -                | -                     | -                      |
| <b>Ni (%)</b>                                                                       | 13               | 80                    | 50                     |
| <b>Cr (%)</b>                                                                       | 17               | 20                    | 50                     |
| <b>Al (%)</b>                                                                       | -                | -                     | -                      |
| <b>Nb (%)</b>                                                                       | -                | -                     | -                      |
| <b>Mo (%)</b>                                                                       | 2                | -                     | -                      |
| <b>Cu (%)</b>                                                                       | -                | -                     | -                      |
| <b>Matrix emission<br/>(mg/180 ml, 28 days,<br/>1N HCl)</b>                         | 948              | 115                   | 256                    |
| <b>Matrix emission<br/>(mg/180 ml, 28 days,<br/>1N H<sub>2</sub>SO<sub>4</sub>)</b> | 944              | 110                   | 131                    |
| <b>Matrix emission<br/>(mg/180 ml, 28 days,<br/>1N citric acid)</b>                 | 25               | 1                     | 35                     |

These results show that the pure matrix alloys performs substantially better in relation to corrosion than when they are used as matrix in the thermal spray powder. It has to be assumed that contact corrosion between the matrix on the one hand and the hard material on the other hand is  
5 responsible for the poor performance of the thermal spray powders.

The pure matrix alloys in the form of spray powders have no wear resistance, because of the absence of hard materials.

- 10 Examples 8 and 9 according to the invention are successful in achieving the acid resistance of pure NiCr 80/20 combined with the wear resistance of commercially available spray materials, as described in examples 1 to 3.

CLAIMS:

1. Cermet powder comprising
  - a) from 50 to 90% by weight of one or more hard materials and
  - b) from 10 to 50% by weight of a matrix metal composition, where the data by  
5 weight are based on the total weight of the cermet powder, wherein the matrix  
metal composition comprises the following:
    - i) from 40 to 75% by weight of iron and nickel,
    - ii) from 18 to 35% by weight of chromium,
    - iii) from 3 to 20% by weight of molybdenum,
    - 10 iv) from 0.5 to 4% by weight of copper,where the data by weight for the metals i) to iv) are based in each case on the  
total weight of the matrix metal composition, and where the ratio by weight of  
iron to nickel is in the range from 3:1 to 1:3.
2. Cermet powder according to Claim 1, wherein the matrix metal composition also  
15 comprises v) cobalt.
3. Cermet powder according to claim 2, wherein the cobalt is present in an amount  
of up to 10% by weight, based on the total weight of the matrix metal  
composition.
4. Cermet powder according to any one of Claims 1 to 3, wherein the matrix metal  
20 composition also comprises vi) modifier.
5. Cermet powder according to claim 4, wherein the modifier is selected from the  
group consisting of Al, Nb, Ti, Ta, V, Si, W and any desired mixtures thereof.
6. Cermet powder according to Claim 4 or 5, wherein the modifier is present in an  
amount of up to 5% by weight, based on the total weight of the matrix metal  
25 composition.

7. Cermet powder according to any one of Claims 1 to 6, wherein the matrix metal composition consists essentially of the following components:
- i) from 40 to 75% by weight of iron and nickel,
  - ii) from 18 to 35% by weight of chromium,
  - 5    iii) from 3 to 20% by weight of molybdenum,
  - iv) from 0.5 to 4% by weight of copper,
  - v) optionally up to 10% by weight of cobalt,
  - vi) optionally up to 5% by weight of one or more modifiers,
- 10    where the data by weight for the metals i) to vi) are based in each case on the total weight of the matrix metal composition, and where the ratio by weight of iron to nickel is in the range from 3:1 to 1:3.
8. Cermet powder according to any one of Claims 1 to 7, wherein the matrix metal composition comprises from 15 to 50% by weight of iron.
9. Cermet powder according to Claim 8, wherein the matrix metal composition
- 15    comprises from 20 to 45% by weight of iron.
10. Cermet powder according to any one of Claims 1 to 9, wherein the matrix metal composition comprises from 15 to 50% by weight of nickel.
11. Cermet powder according to Claim 10, wherein the matrix metal composition comprises from 20 to 45% by weight of nickel.
- 20    12. Cermet powder according to any one of Claims 1 to 11, wherein the matrix metal composition comprises from 20 to 33% by weight of chromium.
13. Cermet powder according to Claim 12, wherein the matrix metal composition comprises from 22 to 31% by weight of chromium.
14. Cermet powder according to any one of Claims 1 to 13, wherein the matrix metal
- 25    composition comprises from 4 to 15% by weight of molybdenum.

15. Cermet powder according to Claim 14, wherein the matrix metal composition comprises from 5 to 10% by weight of molybdenum.
16. Cermet powder according to any one Claims 1 to 15, wherein the matrix metal composition comprises from 0.7 to 3% by weight of copper.
- 5 17. Cermet powder according to Claim 16, wherein the matrix metal composition comprises from 0.9 to 2.0% by weight of copper.
18. Cermet powder according to any one of Claims 1 to 17, wherein the ratio by weight of iron to nickel in the matrix metal composition is from 1:2 to 2:1.
19. Cermet powder according to Claim 18, wherein the ratio by weight of iron to  
10 nickel in the matrix metal composition is from 1:1.5 to 1.5:1.
20. Cermet powder according to any one of Claims 1 to 19, wherein the hard material is metal carbide.
21. Cermet powder according to Claim 20, wherein the metal carbide is selected from the group consisting of WC, Cr<sub>3</sub>C<sub>2</sub>, VC, TiC, B<sub>4</sub>C, TiCN, SiC, TaC, NbC,  
15 Mo<sub>2</sub>C and mixtures thereof.
22. Cermet powder according to Claim 21, wherein the hard material is WC and/or Cr<sub>3</sub>C<sub>2</sub>.
23. Cermet powder according to any one of Claims 1 to 22, wherein the average  
particle size of the powder is from 10 to 100 µm, determined in accordance with  
20 ASTM C1070.
24. Process for producing a cermet powder comprising the following steps:
  - a) mixing or milling of one or more hard-material powders with a pulverulent matrix metal composition which comprises the following:
    - i) from 40 to 75% by weight of iron and nickel,
    - 25 ii) from 18 to 35% by weight of chromium,

iii) from 3 to 20% by weight of molybdenum,  
iv) from 0.5 to 4% by weight of copper,  
where the data by weight for the metals i) to iv) are based in each case on the  
total weight of the matrix metal composition, and where the ratio by weight of iron  
to nickel is in the range from 3:1 to 1:3,  
b) sintering the powder mixture and  
c) optionally pulverizing the mixture sintered in step b).

25. Process according to Claim 24, wherein the sintering takes place under reduced pressure and/or in the presence of an inert gas.

10 26. Process according to Claim 25, wherein the inert gas is selected from the group consisting of hydrogen, argon, nitrogen and mixtures thereof.

27. Process according to any one of Claims 24 to 26, wherein the mixing in step a) takes place via dispersion in a liquid.

15 28. Process according to Claim 27, wherein the mixing via dispersion in a liquid is followed, via removal of the liquid, by a granulation step.

29. Process according to Claim 28, wherein the mixing via dispersion in a liquid takes place via spray drying.

30. Process according to any one of Claims 24 to 29, wherein an alloy powder is used as matrix metal composition.

20 31. Use of the cermet powders according to any one of Claims 1 to 23 for surface coating.

32. Use according to Claim 31, wherein the surface coating takes place via thermal spraying processes.

25 33. Use of the cermet powders according to any one of Claims 1 to 23 as thermal spraying powder.

34. Process for producing a coated component comprising the application of a coating via thermal spraying of a powder according to any one of Claims 1 to 23.
35. Coated component obtained by the process according to Claim 34.
36. Coated component according to Claim 35 for protection from wear under  
5 corrosive environmental conditions.
37. Coated component according to Claim 36 for protection from wear under corrosive environmental conditions at pH values below 7.
38. Coated component according to claim 36 or 37 for protection from wear under corrosive environmental conditions in the presence of chloride salts.
- 10 39. Coated component according to Claim 35, wherein the component is part of an apparatus which comes into contact with media which comprise acids and/or which comprise chloride ions.