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(54) **Powder for Laser Melting Deposition of In-situ Synthesis TiC Reinforced Stainless Steel Matrix Composite Material and Preparation Method.**

(57) The invention relates to a powder for laser melting deposition of in-situ synthesis TiC reinforced stainless steel matrix composite material and a preparation method. The mass fraction of stainless steel alloy powder is selected to be 69%-90%; the mass fraction of Cr3C2 powder is 7%-20%; the mass fraction of Ti powder is 3%-11%. TiC reinforced stainless steel matrix composite is prepared by using laser melting deposition in-situ reaction to synthesize reinforced phase technology, which significantly shortens the production cycle of preparing metal-based composite material at present, improves the manufacturing efficiency and accuracy, and makes the prepared composite have uniform and compact structure and good mechanical properties, thus significantly improving the service life of laser melting deposition stainless steel components, reducing the addition of precious metals, reducing the production cost of stainless steel, and having great economic benefits and society.

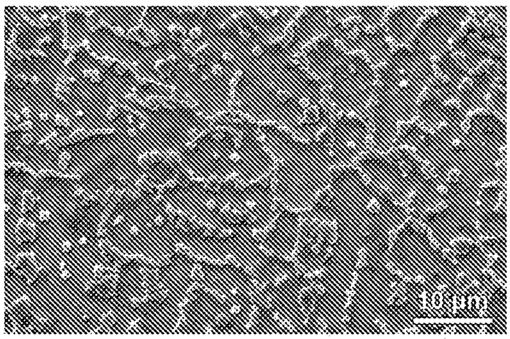

Fig. 3

DESCRIPTION

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POWDER FOR LASER MELTING DEPOSITION OF IN-SITU SYNTHESIS TIC REINFORCED STAINLESS STEEL MATRIX COMPOSITE MATERIAL AND PREPARATION METHOD

TECHNICAL FIELD

The invention is suitable for the field of laser additive manufacturing, in particular to a powder for laser melting deposition of TiC reinforced stainless steel matrix composite material and a preparation method.

BACKGROUND

Stainless steel is widely used in food, petroleum, chemical industry, nuclear power plant, offshore installation and construction industries because of its excellent corrosion resistance in seawater and acid-base medium. However, due to its low hardness (about 200HV), the corrosion resistance of stainless steel is poor, which reduces the service life of stainless steel and limits its application scope. This defect can be overcome by introducing hard ceramic reinforcement phase into stainless steel to prepare TiC reinforced stainless steel matrix composites. Among different metal matrix composites, particle reinforced metal matrix composites have attracted wide attention because of their isotropic mechanical properties. In the past, the research on the manufacturing technology of metal matrix composites often focused on the traditional method of adding reinforcement, but people found that there are many problems in the traditional composite technology, such as poor combination between reinforcement and matrix, easy segregation of reinforcement, complex technology and high cost. In view of the violent reaction between Ti and ceramic phase in the process of high temperature processing, which leads to the decline of some properties of materials, the processing technology of materials is particularly important. Metal matrix composites prepared by in-situ synthesis method have attracted people's attention because of their reinforced phase, which is thermodynamically stable, small in size, uniform in distribution and clean in interface.

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In recent years, the production of large-scale metal parts with complex structures by laser melting deposition technology has become a research hotspot in the field of materials. Laser melting deposition technology is a technology of manufacturing solid parts by gradually accumulating materials, which is a "bottom-up" manufacturing method compared with the traditional material removal-cutting technology. Compared with traditional processing technology, laser melting deposition technology has the characteristics of high flexibility in manufacturing process, short production cycle and fast processing speed, and can produce parts with complex structures. In addition, the laser melting deposition process has the advantages of fast melting speed, fine structure of forming materials and uniform distribution of reinforcing phases, which has a profound impact on the traditional processing and manufacturing industry. By selecting different proportions of stainless steel alloy powder, Cr_3C_2 and Ti powder, this patent technology reveals the formation mechanism and microstructure and performance characteristics of in-situ synthesis TiC reinforced stainless steel matrix composite prepared by laser melting deposition, thus obtaining a new proprietary technology of laser melting deposition, which is of great significance for expanding the application field of laser additive manufacturing stainless steel. In-situ synthesis TiC reinforced stainless steel matrix composites made by laser additive manufacturing have the advantages of low cost, high hardness, excellent corrosion resistance and good wear resistance, and can be widely used in parts with high requirements for plasticity and impact load, such as turbine blades, large axial compressor blades, fasteners, valve bodies, shaft pump sleeves, bearings, etc., thus prolonging the service life of stainless steel components and expanding their engineering application scope.

SUMMARY

Purpose of the invention:

The purpose of this invention is to provide powder for laser melting deposition of in-situ synthesis TiC reinforced stainless steel matrix composite materials and its preparation method. Using laser melting deposition technology, stainless steel alloy powder, Cr_3C_2 and Ti powder with different proportions are selected, and TiC reinforced stainless steel matrix composites are prepared by in-situ reaction synthesis reinforced phase technology, which overcame the disadvantages of interface reaction, particle cracking, uneven distribution and limited volume fraction of ceramic reinforced phase during high temperature processing.

And provided an effective way to prepare new laser additive stainless steel matrix composites with high mechanical properties and high environmental resistance.

Technical scheme:

The powder for laser melting deposition of in-situ synthesis TiC reinforced stainless steel matrix composite material is characterized in that the alloy powder includes stainless steel alloy powder, Cr_3C_2 powder and Ti powder, and the mass fraction of the stainless steel alloy powder is 69%-90%; the mass fraction of Cr_3C_2 powder is 7%-20%; the mass fraction of Ti powder is 3%-11%.

The particle size of the alloy powder is 50-180μm, and the purity of Cr_3C_2 powder and Ti powder is not less than 99.9%.

The method for preparing the in-situ synthesis TiC reinforced stainless steel matrix composite material by using the powder used for depositing the stainless steel matrix composite material by laser melting is characterized in that:

firstly, the substrate material is processed into the required sample size by a numerical control wire cutting machine, and the surface of the substrate is polished to 500#SiC metallographic sandpaper in turn, and the oxide layer is removed until the metallic luster is exposed, then carry out sand blast, ultrasonic cleaning with alcohol or acetone solution and dry for later use;

then weigh and mix the stainless steel alloy powder, Cr_3C_2 powder and Ti powder with different proportions according to the proportion of the powder according to claim 1, mix the powder by ball milling or grinding, and then dry the evenly mixed powder in a vacuum drying oven at 80 °C for 2-8 h for later use;

the fiber laser processing system is used for laser melting deposition. The laser output power is 2 kW, the spot diameter is 5 mm, the scanning speed is 8 mm/s, the powder feeding rate is 11g/min, and the scanning overlap rate of large-area laser beam is 40%. The laser melting deposition process is carried out in an Ar gas protection room, and the Ar gas flow rate is 400-500 L/h; during laser irradiation, Cr_3C_2 decomposes into free Cr and C atoms, and C atoms combine with Ti atoms to form TiC, thus preparing in-situ synthesis TiC reinforced stainless steel matrix composites.

Ball milling is ball milling in a planetary ball mill. Ball milling and grinding the mixed powder are carried out at room temperature, the room temperature is 23±1°C, the relative humidity is 40 ±10%, and the powder grinding time is 2-5 h.

Advantages and effects:

The invention relates to powder for laser melting deposition of in-situ synthesis TiC reinforced stainless steel matrix composite material and a preparation method, and has the following advantages:

TiC reinforced stainless steel matrix composites are prepared by using different proportions of stainless steel alloy powder, Cr_3C_2 and Ti powder and in-situ reaction synthesis reinforced phase technology. The preparation method has the characteristics of high flexibility in manufacturing process, short production cycle, fast processing speed, and the ability to produce parts with complex structures. The composite material has the advantages of low cost, high hardness, good corrosion resistance and excellent wear resistance. The reinforced phase of stainless steel matrix composite prepared by laser melting deposition has the remarkable characteristics of thermodynamic stability, small size, uniform distribution, clean interface and good combination with matrix, and can be used to manufacture complex structural parts with high requirements of plasticity and impact load, providing a new way for preparing new composite materials with high mechanical properties and high environmental resistance.

Laser melting deposition technology significantly shortens the production cycle and significantly improves the manufacturing efficiency and accuracy of complex parts. At the same time, the laser melting deposition manufacturing process is also a rapid solidification process, which makes the prepared composite material uniform and compact in structure and good in mechanical properties, thus significantly improves the service life of laser melting deposition stainless steel materials. At the same time, the use of laser additive manufacturing technology significantly reduces the addition of precious metals and the production cost of stainless steel, which has great economic benefits and is one of the first choice processing technologies for modern equipment manufacturing industry in China.

BRIEF DESCRIPTION OF THE FIGURES

Fig. 1 is the XRD spectrum of in-situ synthesis TiC reinforced stainless steel matrix composite material prepared by laser melting deposition, in which the scale above the curve is stainless steel alloy: Cr_3C_2: Ti (Wt%);

Fig. 2 is the curve of Gibbs free energy of TiC, Fe_3C, Fe_2Ti and FeTi with temperature;

Fig. 3 shows the SEM images of in-situ synthesis TiC reinforced stainless steel matrix steel matrix composite material prepared by laser melting deposition when the mass ratio of stainless steel alloy powder, Cr_3C_2 powder and Ti powder is 90:7:3;

Fig. 4 is the SEM image of in-situ synthesis TiC reinforced stainless steel matrix composite material prepared by laser melting deposition when the mass ratio of stainless steel alloy powder, Cr_3C_2 powder and Ti powder is 69:20:11;

Fig. 5 shows the inverse pole figure of in-situ synthesis TiC reinforced stainless steel matrix composite material prepared by laser melting deposition when the mass ratio of stainless steel alloy powder, Cr_3C_2 powder and Ti powder is 90:7:3;

Fig. 6 shows the inverse pole figure of in-situ synthesis TiC reinforced stainless steel matrix composite material prepared by laser melting deposition when the mass ratio of stainless steel alloy powder, Cr_3C_2 powder and Ti powder is 69:20:11;

Fig. 7 is a polar diagram of in-situ synthesis TiC reinforced stainless steel matrix composite material prepared by laser melting deposition when the mass ratio of stainless steel alloy powder, Cr_3C_2 powder and Ti powder is 90:7:3;

Fig. 8 is the polar diagram of in-situ synthesis TiC reinforced stainless steel matrix composite material prepared by laser melting deposition when the mass ratio of stainless steel alloy powder, Cr_3C_2 powder and Ti powder is 69:20:11;

Fig. 9 shows the hardness distribution of in-situ synthesis TiC reinforced stainless steel matrix composite material prepared by laser melting deposition, in which the following scale is stainless steel alloy: Cr_3C_2: Ti (Wt%);

Fig. 10 shows the relative wear resistance of in-situ synthesis TiC reinforced stainless steel matrix composite material prepared by laser melting deposition, in which the scale below is stainless steel alloy: Cr_3C_2: Ti (Wt%).

DESCRIPTION OF THE INVENTION

The present invention will be further described with reference to the attached figures and specific embodiments:

The invention relates to powder used for laser melting deposition of in-situ TiC reinforced stainless steel matrix composite material and a preparation method. The alloy powder includes stainless steel alloy powder, Cr_3C_2 powder and Ti powder, where the mass fraction of the stainless steel alloy powder is 69%-90%; the mass fraction of Cr_3C_2 powder is 7%-20%; the mass fraction of Ti powder is 3%-11%. The particle size of alloy powder is 50-180μm, and the purity of Cr_3C_2 powder and Ti powder is not less than 99.9%.

The alloy powder with particle size of 50-180μm is selected because the nozzle of powder feeder is easily blocked when the particle size is smaller (less than 50μm), and the TiC reinforced stainless steel matrix composite material synthesis with larger particle size (more than 180 μm) has more internal defects. When the particle size of powder is within this range, the utilization rate of laser melting deposition processing powder is high and the forming quality of composite materials is good.

The above-mentioned stainless steel powder is preferably 316L stainless steel powder, and other stainless steel matrix powder materials such as 316 or 304 can be used to mix and use the powder in a proper proportion. The reinforcing phase of in-situ reaction synthesis can also be WC and VC hard particle reinforcing phase.

Method for preparing in-situ synthesis TiC-reinforced stainless steel matrix composite material by laser melting powder for depositing stainless steel matrix composite material;

firstly, the substrate material is processed into the required sample size by using a numerical control wire cutting machine, and the surface of the substrate is polished to $500^{\#}$SiC metallographic sandpaper in turn, and the oxide layer is removed until the metallic luster is exposed, then carry out sand blast, ultrasonic cleaning with alcohol or acetone solution and dry for later use;

then mix the stainless steel alloy powder, Cr_3C_2 powder and Ti powder according to different proportions, wherein the mass fraction of the stainless steel alloy powder is 69%-90%; The mass fraction of Cr_3C_2 powder is 7%-20%; The mass fraction of Ti powder is 3%-11%, the powder is mixed at room temperature of 23±1°C and relative humidity of 40±10%, ball milling or grounding by planetary ball mill for 2-5 h, and then the evenly mixed powder is dried in a vacuum drying box at 80°C for 2-8 h;

the fiber laser processing system is used for laser melting deposition. The powder feeding mode is coaxial powder feeding, the laser output power is 2 kW, the spot diameter is 5 mm, the scanning speed is 8 mm/s, the powder feeding rate is 11g/min, and the scanning overlap rate of large-area laser beam is 40%. The laser melting deposition process is carried out in an Ar gas chamber with a flow rate of 400–500 L/h; During laser irradiation, Cr_3C_2 decomposes into free Cr and C atoms, and C atoms combine with Ti atoms to form TiC, thus preparing in-situ synthesis TiC reinforced stainless steel matrix composites.

The present invention will be described in detail with reference to the following embodiments, but the present invention is not limited to the following embodiments.

Embodiment 1

The mass ratio of stainless steel alloy powder, Cr_3C_2 powder and Ti powder is 90:7:3, and the in-situ synthesis TiC reinforced stainless steel matrix composite material is prepared by laser melting deposition technology. The specific preparation process steps are as follows:

According to the mass ratio of stainless steel alloy, Cr_3C_2 and Ti alloy powder of 90:7:3, the in-situ synthesis TiC reinforced stainless steel matrix composite material powder is prepared. The prepared alloy powder needed to be milled and mixed in a planetary ball mill or mortar for 2 hours, and the evenly mixed powder is dried in a vacuum drying oven at 80°C for 2 hours. Using fiber laser processing system, the laser output power is 2 kW, the spot diameter is 5 mm, the scanning speed is 8 mm/s, the powder feeding rate is 11g/min, and the scanning overlap rate of large-area laser beam is 40%. The laser melting deposition process is carried out in an Ar gas protection room, and the Ar gas flow rate is 400 L/h. During laser irradiation, Cr_3C_2 decomposes into free Cr and C atoms, and C atoms combine with Ti atoms to form TiC, so as to prepare in-situ synthesis TiC reinforced stainless steel matrix composite material by laser melting deposition.

Embodiment 2

The mass ratio of stainless steel alloy powder, Cr_3C_2 powder and Ti powder is 69:20:11, and in-situ synthesis TiC reinforced stainless steel matrix composite material is prepared by laser melting deposition. The specific preparation process steps are as follows:

According to the mass ratio of stainless steel alloy, Cr_3C_2 and Ti alloy powder of 69:20:11, the in-situ synthesis TiC reinforced stainless steel matrix composite material powder is prepared.

The prepared alloy powder needed to be milled and mixed in a planetary ball mill for 5 h, and the evenly mixed powder is dried in a vacuum drying oven at 80°C for 8 h. Using fiber laser processing system, the laser output power is 2 kW, the spot diameter is 5 mm, the scanning speed is 8 mm/s, the powder feeding rate is 11g/min, and the scanning overlap rate of large-area laser beam is 40%. The laser melting deposition process is carried out in an Ar gas chamber with a flow rate of 500 L/h. During laser irradiation, Cr_3C_2 decomposes into free Cr and C atoms, and C atoms combine with Ti atoms to form TiC, so as to prepare in-situ TiC reinforced stainless steel matrix composites by laser melting deposition.

The samples prepared in Embodiment 1 and Embodiment 2 are tested for hardness. The specific testing process parameters are: normal load 2 N, loading time 10 s, and the average of seven test results is taken for each sample. The hardness test results are shown in Fig. 9, and the hardness is higher than that of ordinary stainless steel.

The wear resistance of the samples prepared in Embodiment 1 and Embodiment 2 is tested. The specific technological parameters of the wear experiment are: ball-disk wear, the upper friction pair is a Si_3N_4 ceramic ball with a diameter of 6mm, and the lower friction pair is a 10mm×10mm×10mm laser melting deposition sample. The normal load is 10 N, the sliding rate is 2.5 mm/s, the displacement amplitude is 5 mm, and the time is 60 min. Under the same conditions, wear experiments are carried out for three times, and the wear resistance is higher than that of ordinary stainless steel, as shown in Fig. 10.

Embodiments show that in the process of laser irradiation, Cr_3C_2 decomposes into free Cr and C atoms, and C atoms combine with Ti atoms to form TiC, so as to prepare in-situ synthesis TiC reinforced stainless steel matrix composite material by laser melting deposition. Compared with the traditional processing technology, the in-situ synthesis of TiC reinforced stainless steel matrix composites prepared by laser melting deposition has the advantages of high flexibility in manufacturing process, short production cycle and fast processing speed, and can produce parts with complex structures. In addition, the in-situ synthesis of TiC reinforced stainless steel matrix composites prepared by laser melting deposition has the advantages of fast melting speed, fine sample structure and uniform distribution of reinforcing phases. This has a profound impact on the traditional processing and manufacturing industry.

In-situ synthesis TiC reinforced stainless steel matrix composite material made by laser additive manufacturing have the advantages of low cost, high hardness, excellent corrosion resistance and good wear resistance, and can be widely used in parts with high requirements for plasticity and impact load, such as turbine blades, large axial compressor blades, fasteners, valve bodies, shaft pump sleeves, bearings, etc., thus prolonging the service life of stainless steel and expanding its application scope.

The invention will be further described with reference to the attached figures:

Fig. 1 is the XRD spectrum of in-situ synthesis TiC reinforced stainless steel matrix composite material prepared by laser melting deposition. It can be seen that the matrix phase of the samples is γ-Fe, and there are TiC diffraction peaks, which confirms the feasibility of in-situ synthesis of TiC reinforced stainless steel matrix composite material by laser melting deposition. With the increase of Cr_3C_2 and Ti powder, the intensity of TiC diffraction peak increases. When the mass ratios of stainless steel, Cr_3C_2 and Ti alloy powder are 81:12:7 and 69:20:11, α-Fe diffraction peaks appear in the samples. This is because, firstly, Cr promotes the formation of α-Fe; secondly, the thermal expansion coefficients of in-situ synthesis TiC ceramic phase and matrix phase are quite different, which produces tensile stress during laser melting deposition; thirdly, the comprehensive effect of rapid melting and solidification of laser is beneficial to promote the formation of α-Fe phase.

According to the Fe-Ti-C ternary phase diagram, the Gibbs free energies of TiC, Fe_3C, Fe_2Ti and FeTi are calculated as follows:

$Ti+1/2Cr_3C_2=TiC+3/2Cr$

$$\Delta G_1=-143748-8.647T+5.598T\ln T-2.339\times10^{-3}T^2+12.168\times10^5T^{-1}-0.314\times10^{-6}T^3 \quad (1155-1600K) \qquad (1)$$

$3Fe+C=Fe_3C$

$$\Delta G_2=30569+36.887T-10.786T\ln T+6.473\times10^{-3}T^2-15.816\times10^5T^{-1} \quad (1184-1500K) \qquad (2)$$

$2Fe+Ti=Fe_2Ti$

$$\Delta G_3=-95305+102.948T-13.146T\ln T+5.411\times10^{-3}T^2+6.59\times10^5T^{-1} \quad (1184-1665K) \quad (3)$$

$Fe+Ti=FeTi$

$$\Delta G_4=-45751+69.313T-9.188T\ln T+3.323\times10^{-3}T^2+4.059\times10^5T^{-1} \quad (1184-1590K) \quad (4)$$

The above formula T represents temperature, and the unit is K; ΔG stands for Gibbs free energy in J/mol.

Fig. 2 shows the Gibbs free energy ΔG of TiC, Fe_3C, Fe_2Ti and FeTi as a function of temperature. It can be seen from the figure that the Gibbs free energy ΔG of TiC, Fe_3C, Fe_2Ti and FeTi are all negative in the temperature range, indicating that the above reactions are spontaneous. However, the Gibbs free energy ΔG of TiC is one order of magnitude lower than that of Fe_3C and FeTi, and much lower than that of Fe_2Ti, indicating that the ability to form TiC is much higher than that of Fe_3C, Fe_2Ti and FeTi. According to the Fe-Ti-C ternary phase diagram, when the carbon content is high, the Ti-C liquid phase begins to solidify at a higher temperature (high liquidus) and experiences a wider temperature range (low solidus), so TiC begins to precipitate before other phases solidify.

Figs. 3 and 4 are SEM images of in-situ synthesis TiC reinforced stainless steel matrix composite material prepared by laser melting deposition. It can be seen that with the gradual increase of Cr_3C_2 and Ti, the number and size of in-situ synthesis TiC particles increase, and eutectic structure appears, and the grains of matrix phase are significantly refined, which is due to the preferential solidification of TiC as heterogeneous nucleation core, which improves the heterogeneous nucleation rate. Because TiC and Fe have good wettability, TiC is well combined with matrix, the interface is clean, the size is small and the distribution is uniform.

Figs. 5, 6, 7 and 8 are inverse pole figure and polar diagrams of in-situ synthesis TiC reinforced stainless steel matrix composites prepared by laser melting deposition. It can be seen that for the samples with the mass ratios of stainless steel alloy powder, Cr_3C_2 powder and Ti powder of 90:7:3 and 81:12:7, the grains grow along the {100} crystal plane family; the mass ratios of stainless steel alloy powder, Cr_3C_2 powder and Ti powder are 81:12:7 and 69:20:11, and the preferred growth orientations are < 101 > and < 111 >, respectively, indicating that the volume fraction and particle size of TiC have an influence on the formation of sample texture. In the figure, red represents the preferential growth of crystal grains along the {001} crystal plane family, blue represents the preferential growth of crystal grains along the {111} crystal plane family, and green represents the preferential growth of crystal grains along the {101} crystal plane family. The {100} represents the projection onto the {100} crystal plane to observe its preferred growth orientation.

Fig. 9 shows the hardness distribution of in-situ synthesis TiC reinforced stainless steel matrix composite material prepared by laser melting deposition. For the alloys with powder mass ratios of 90:7:3, 81:12:7 and 69:20:11, the hardness is 360HV, 420HV and 540HV, respectively, indicating that the hardness gradually increases with the gradual increase of Cr_3C_2 and Ti.

Fig. 10 shows the relative wear resistance of in-situ synthesis TiC reinforced stainless steel matrix composites prepared by laser melting deposition.

Relative wear resistance can be characterized as:

Relative wear resistance = laser melting deposition sample wear weight loss/stainless steel wear weight loss.

It can be seen that the relative wear resistance of in-situ synthesis TiC reinforced stainless steel matrix composite material prepared by laser melting deposition is much higher than that of stainless steel, and the wear resistance is obviously improved with the gradual increase of Cr_3C_2 and Ti.

CLAIMS

1. A powder for laser melting deposition of in-situ synthesis TiC reinforced stainless steel matrix composite material, characterized in that the alloy powder comprises stainless steel alloy powder, Cr_3C_2 powder and Ti powder, and the mass fraction of the stainless steel alloy powder is 69%-90%; the mass fraction of Cr_3C_2 powder is 7%-20%; the mass fraction of Ti powder is 3%-11%.

2. The powder for laser melting deposition of in-situ synthesis TiC reinforced stainless steel matrix composite material according to claim 1, characterized in that the particle size of the alloy powder is 50-180μm, and the purity of Cr_3C_2 powder and Ti powder is not lower than 99.9%.

3. A method for preparing in-situ synthesis TiC reinforced stainless steel matrix composite material by using powder for laser melting deposition of stainless steel matrix composite material according to claim 1, characterized in that:

firstly, the substrate material is processed into the required sample size by a numerical control wire cutting machine, and the surface of the substrate is polished to 500#SiC metallographic sandpaper in turn, and the oxide layer is removed until the metallic luster is exposed, then carry out sand blast, ultrasonic cleaning with alcohol or acetone solution and dry for later use;

then weigh and mix the stainless steel alloy powder, Cr_3C_2 powder and Ti powder according to the proportion of the powder according to claim 1, and mix the powder by ball milling or grinding, and then put the evenly mixed powder in a vacuum drying oven at 80 °Cfor 2-8 h for standby;

the fiber laser processing system is used for laser melting deposition; the laser output power is 2 kW, the spot diameter is 5 mm, the scanning speed is 8 mm/s, the powder feeding rate is 11g/min, and the scanning overlap rate of large-area laser beam is 40%; the laser melting deposition process is carried out in an Ar gas protection room, and the Ar gas flow rate is 400-500 L/h; during laser irradiation, Cr_3C_2 decomposes into free Cr and C atoms, and C atoms combine with Ti atoms to form TiC, thus preparing in-situ synthesis TiC reinforced stainless steel matrix composites.

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4. The method for preparing in-situ synthesis TiC reinforced stainless steel matrix composite material by using powder for laser melting deposition of stainless steel matrix composite material according to claim 3, characterized in that the mixture is ball-milled in a planetary ball mill.

5. The method for preparing in-situ synthesis TiC reinforced stainless steel matrix composite material by using powder for laser melting deposition of stainless steel matrix composite material according to claim 3, characterized in that ball milling or grinding mixed powder is carried out at room temperature, the room temperature is 23±1°C, the relative humidity is 40±10%, and the powder grinding time is 2-5 h.

PATENTANSPRÜCHE LU508513

1. Pulver für die Laserschmelzabscheidung eines in-situ synthetisiertem TiC verstärkten Verbundwerkstoffs mit rostfreier Stahlmatrix, dadurch gekennzeichnet, dass das Legierungspulver Pulver der Edelstahllegierung, Cr3C2-Pulver und Ti-Pulver umfasst und der Massenanteil des Pulvers der Edelstahllegierung 69 % - 90 % beträgt; der Massenanteil des Cr3C2-Pulvers 7 % - 20 % beträgt; der Massenanteil des Ti-Pulvers 3 % - 11 % beträgt.

2. Pulver für die Laserschmelzabscheidung eines in-situ synthetisiertem TiC verstärkten Verbundwerkstoffs mit rostfreier Stahlmatrix nach Anspruch 1, dadurch gekennzeichnet, dass die Partikelgröße des Legierungspulvers 50-180 μm beträgt und die Reinheit des Cr3C2-Pulvers und des Ti-Pulvers nicht unter 99,9% liegt.

3. Verfahren zur Herstellung eines in-situ synthetisiertem TiC verstärkten Verbundwerkstoffs mit rostfreier Stahlmatrix unter Verwendung von Pulver für die Laserschmelzabscheidung vom Verbundwerkstoff mit rostfreier Stahlmatrix nach Anspruch 1, dadurch gekennzeichnet, dass:
zunächst Bearbeiten des Substratmaterials mit einer numerisch gesteuerten Drahtschneidemaschine auf die erforderliche Probengröße, Polieren der Oberfläche des Substrats der Reihe nach mit metallografischem Schleifpapier 500#SiC und Entfernen der Oxidschicht, bis der Metallglanz freigelegt ist, dann Durchführen des Sandstrahlens und der Ultraschallreinigung mit Alkohol oder Aceton-Lösung, und Trocknen für die spätere Verwendung;
dann Wiegen und Mischen des Edelstahllegierungspulvers, Cr3C2-Pulvers und Ti-Pulvers entsprechend dem Verhältnis des Pulvers nach Anspruch 1, und Mischen des Pulvers durch Kugelmahlen oder Mahlen, und dann Geben des gleichmäßig gemischten Pulvers in einen Vakuumtrockenofen bei 80°C für 2-8 h zur Bereitschaft; und
das Faserlaser-Bearbeitungssystem wird für das Laserschmelzabscheiden verwendet; die Laserausgangsleistung beträgt 2 kW, der Punktdurchmesser beträgt 5 mm, die Scan-

Geschwindigkeit beträgt 8 mm/s, die Zuführungsrate des Pulvers beträgt 11 g/min, und die Scanüberlappungsrate des großflächigen Laserstrahls beträgt 40%; das Laserschmelzverfahren wird in einem Ar-Schutzraum durchgeführt, und der Ar-Durchflussrate beträgt 400-500 l/h; während der Laserbestrahlung zerfällt Cr3C2 in freie Cr- und C-Atome, und C-Atome verbinden sich mit Ti-Atomen, um TiC zu bilden, wodurch in-situ synthetisierte TiC-verstärkte Edelstahlmatrix-Verbundwerkstoffe hergestellt werden.

4. Verfahren zur Herstellung eines in-situ synthetisiertem TiC verstärkten Verbundwerkstoffs mit rostfreier Stahlmatrix unter Verwendung von Pulver für die Laserschmelzabscheidung vom Verbundwerkstoff mit rostfreier Stahlmatrix nach Anspruch 3, dadurch gekennzeichnet, dass die Mischung in einer Planetenkugelmühle kugelgemahlen wird.

5. Verfahren zur Herstellung eines in-situ synthetisiertem TiC verstärkten Verbundwerkstoffs mit rostfreier Stahlmatrix unter Verwendung von Pulver für die Laserschmelzabscheidung vom Verbundwerkstoff mit rostfreier Stahlmatrix nach Anspruch 3, dadurch gekennzeichnet, dass das Kugelmahlen oder Mahlen des gemischten Pulvers bei Raumtemperatur durchgeführt wird, die Raumtemperatur 23±1°C beträgt, die relative Luftfeuchtigkeit 40±10% beträgt und die Pulvermahlzeit 2-5 h beträgt.

FIGURES

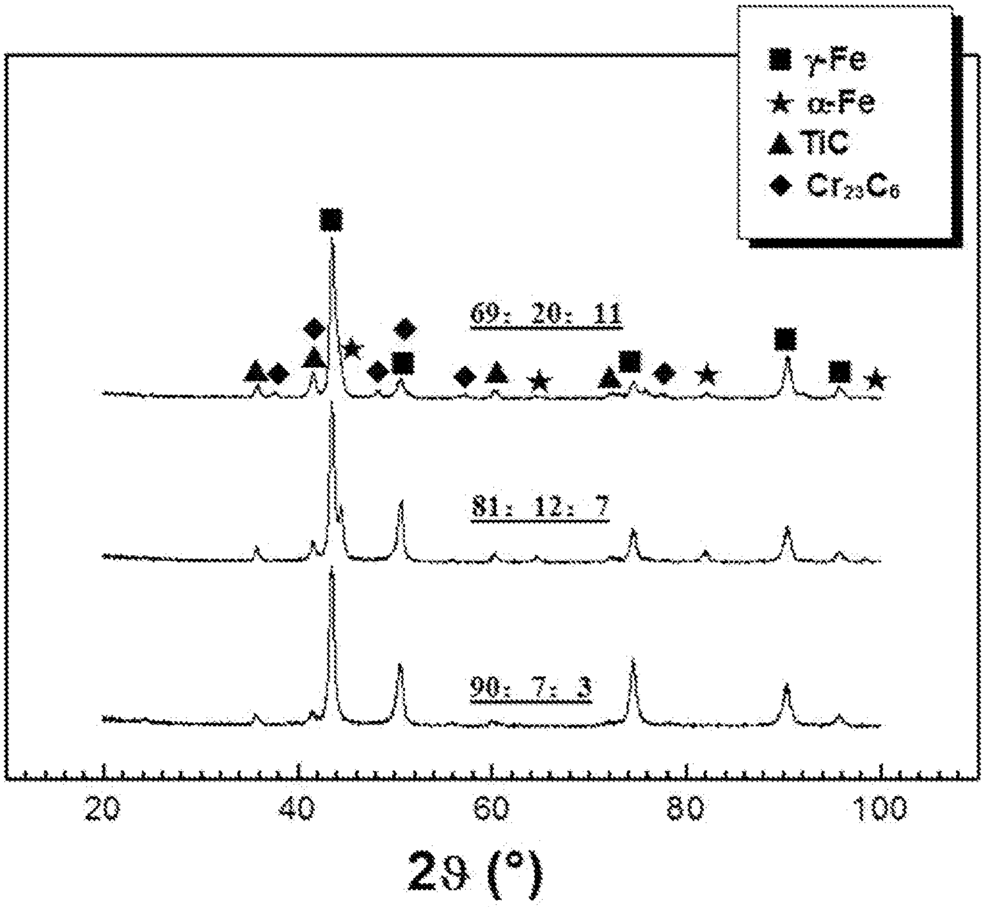

Fig. 1

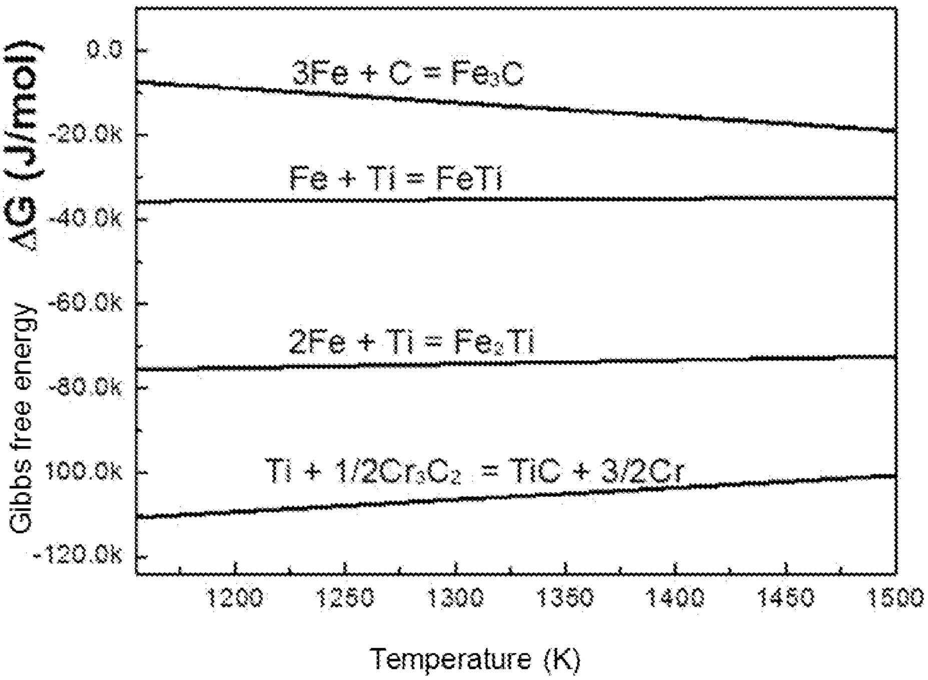

Fig. 2

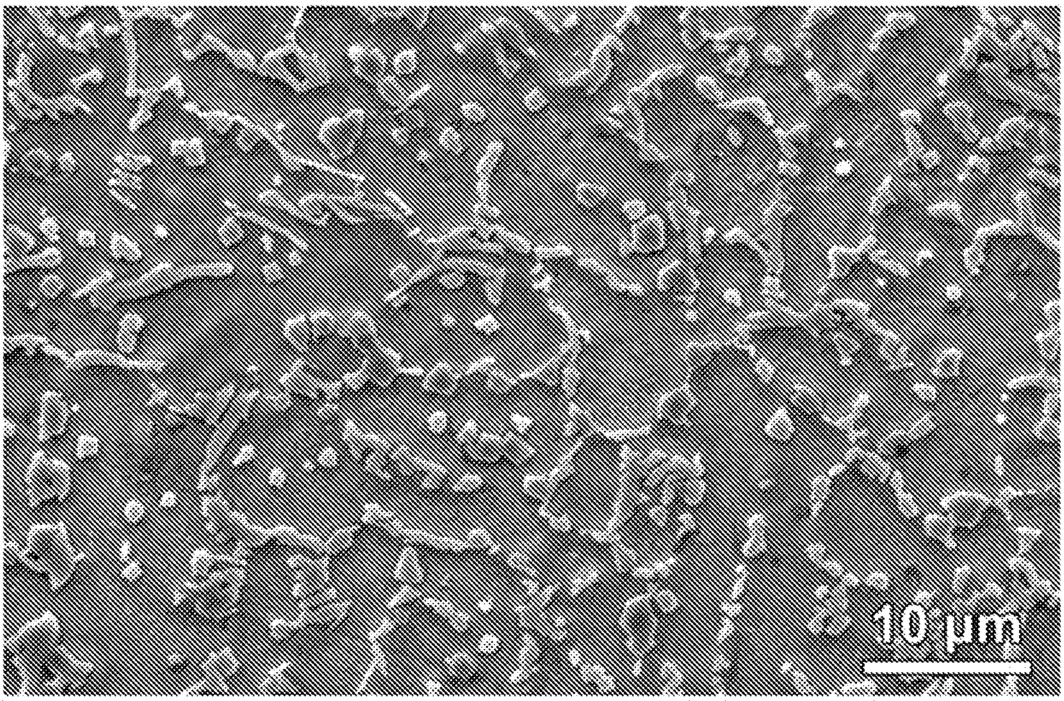

Fig. 3

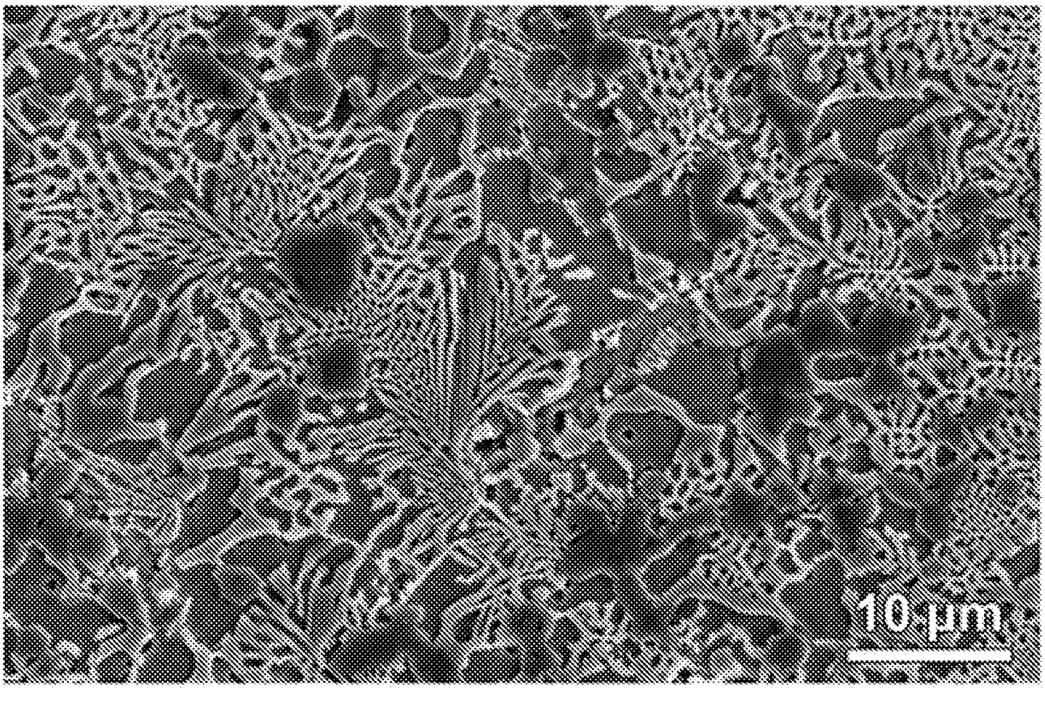

Fig. 4

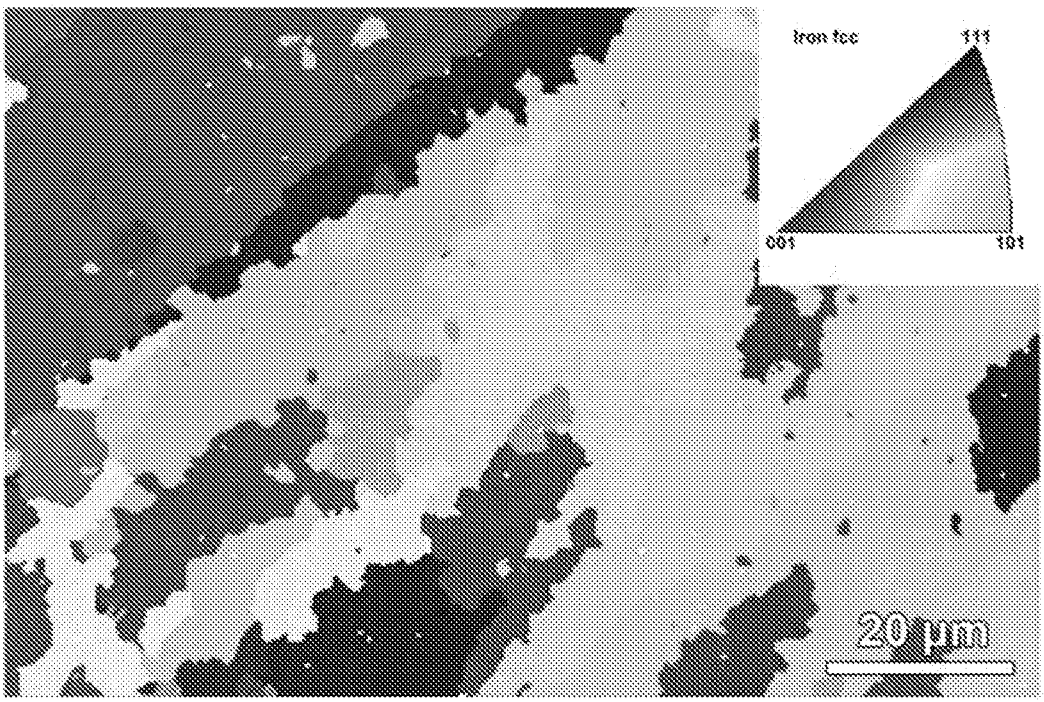

Fig. 5

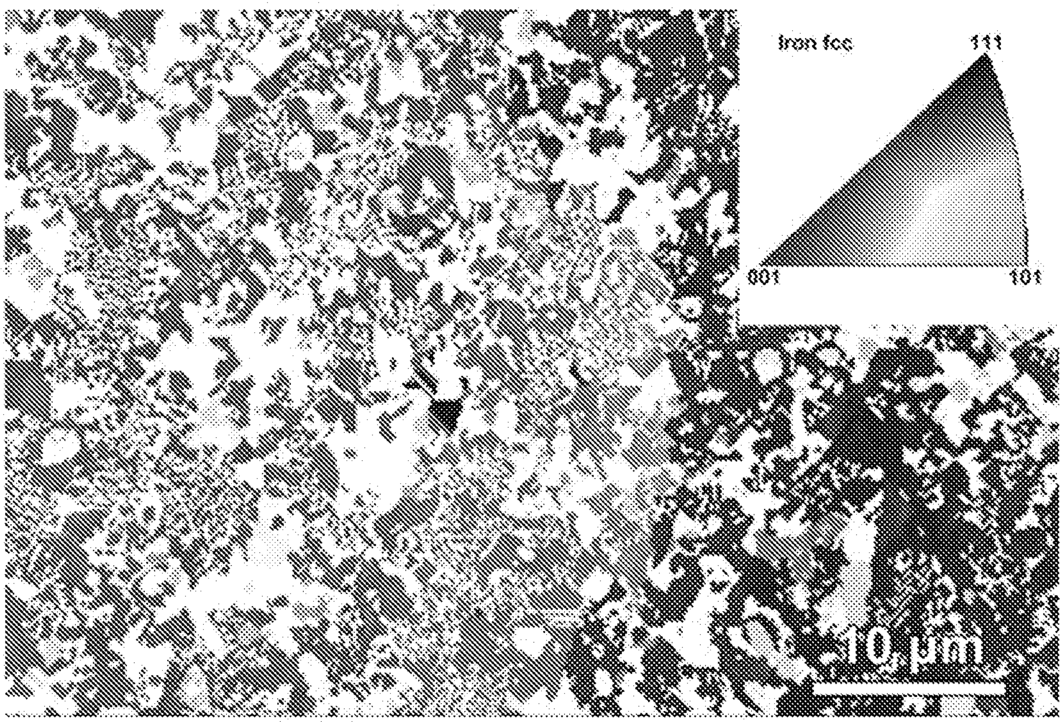

Fig. 6

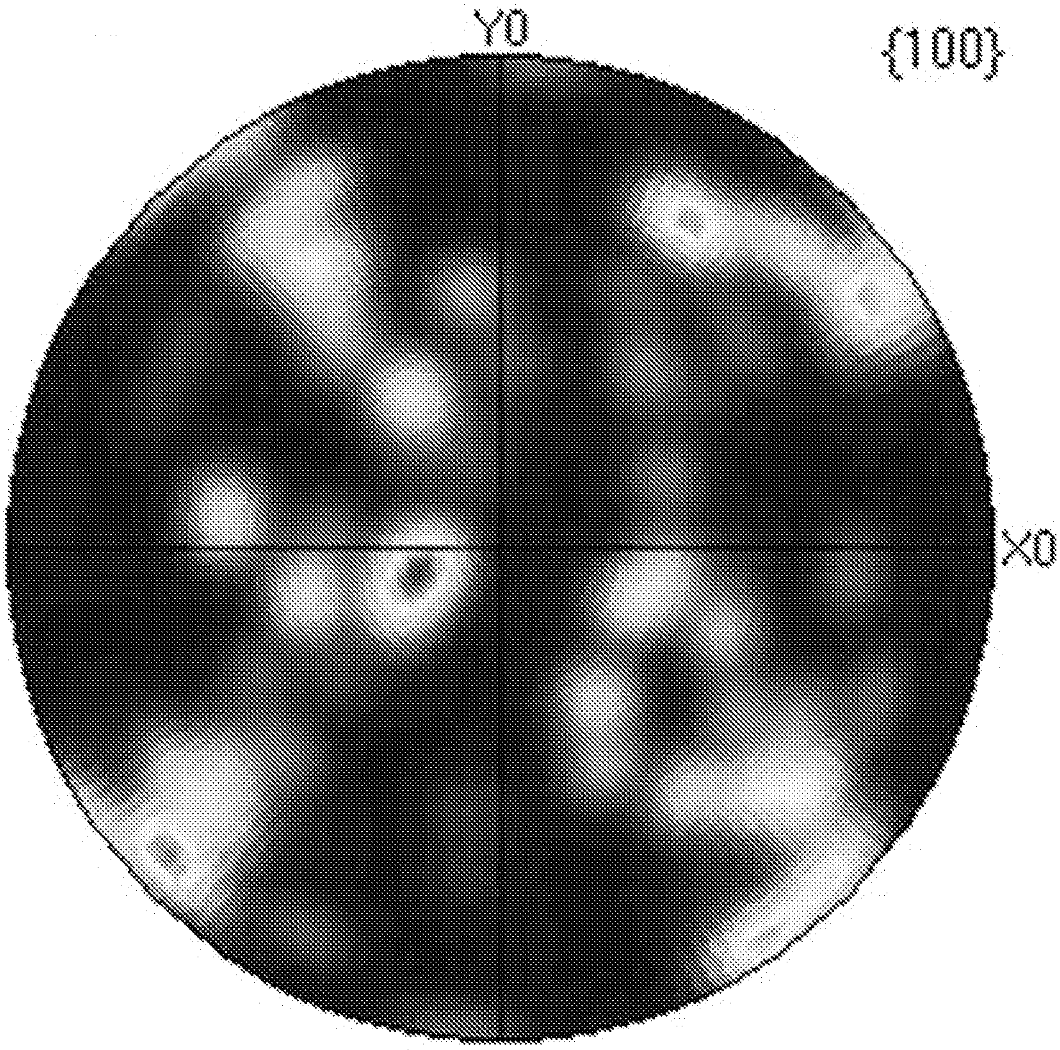

Fig. 7

LU508513

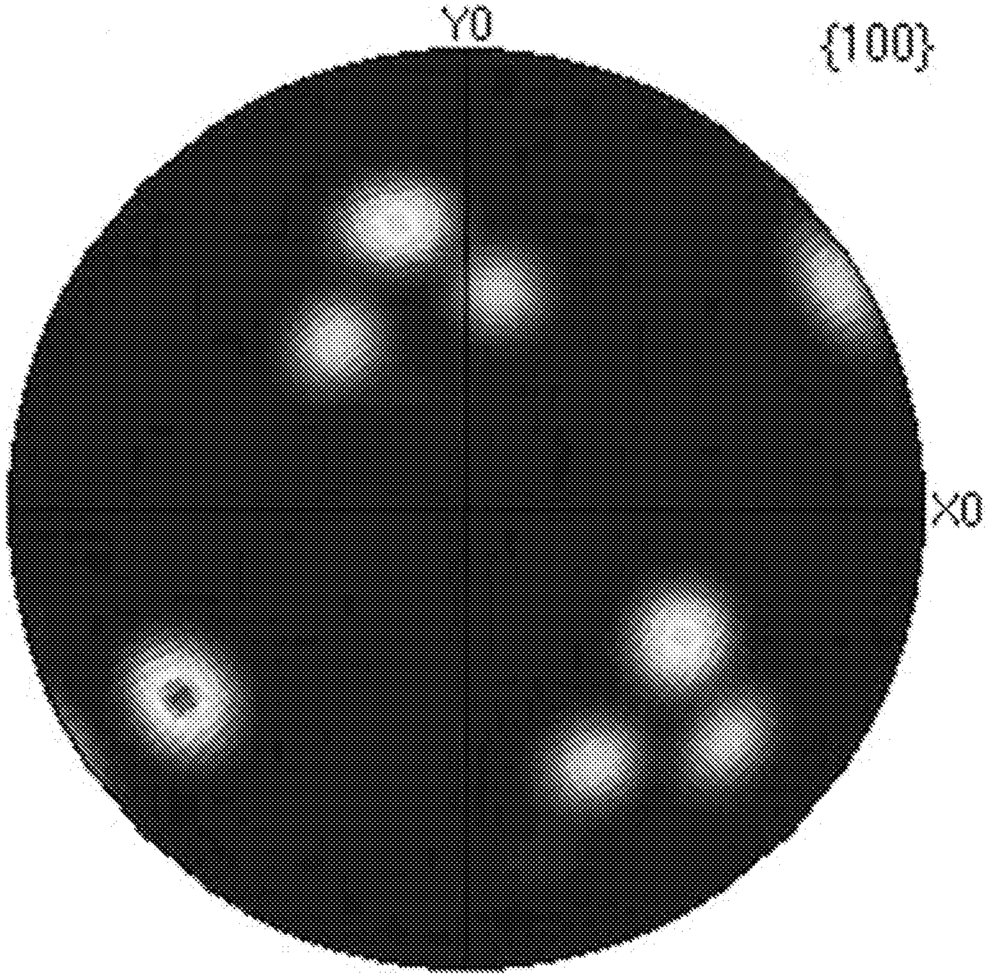

Fig. 8

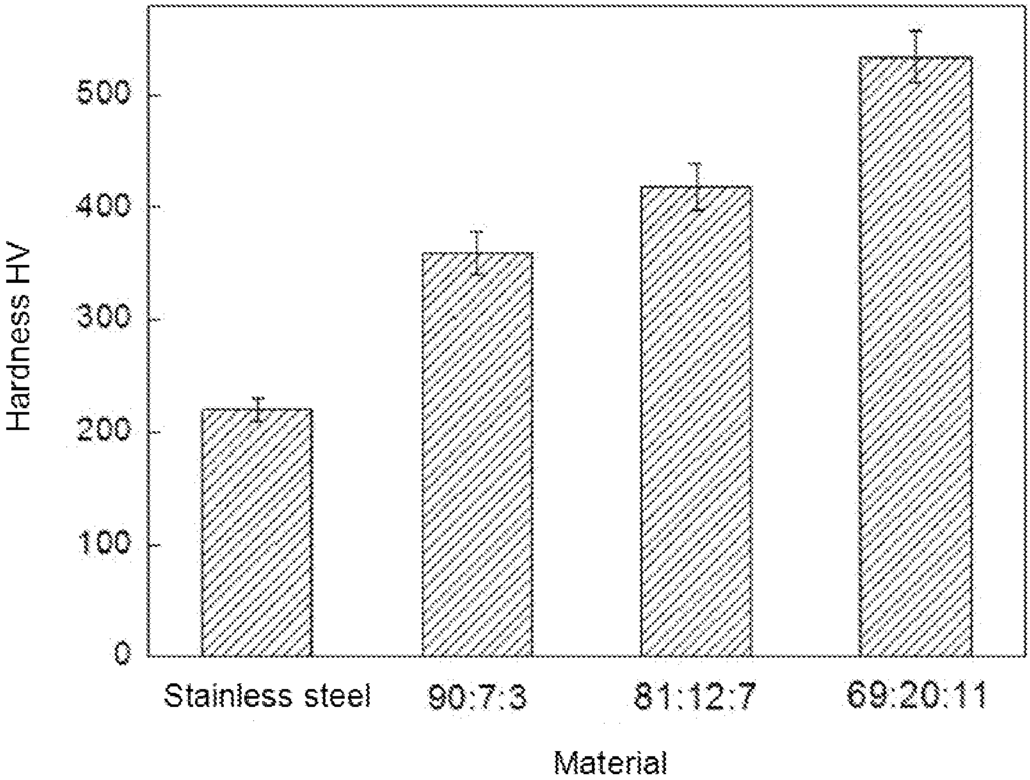
Hardness HV
500
400
300
200
100
0
Stainless steel
90:7:3
81:12:7
69:20:11
Material

Fig. 9

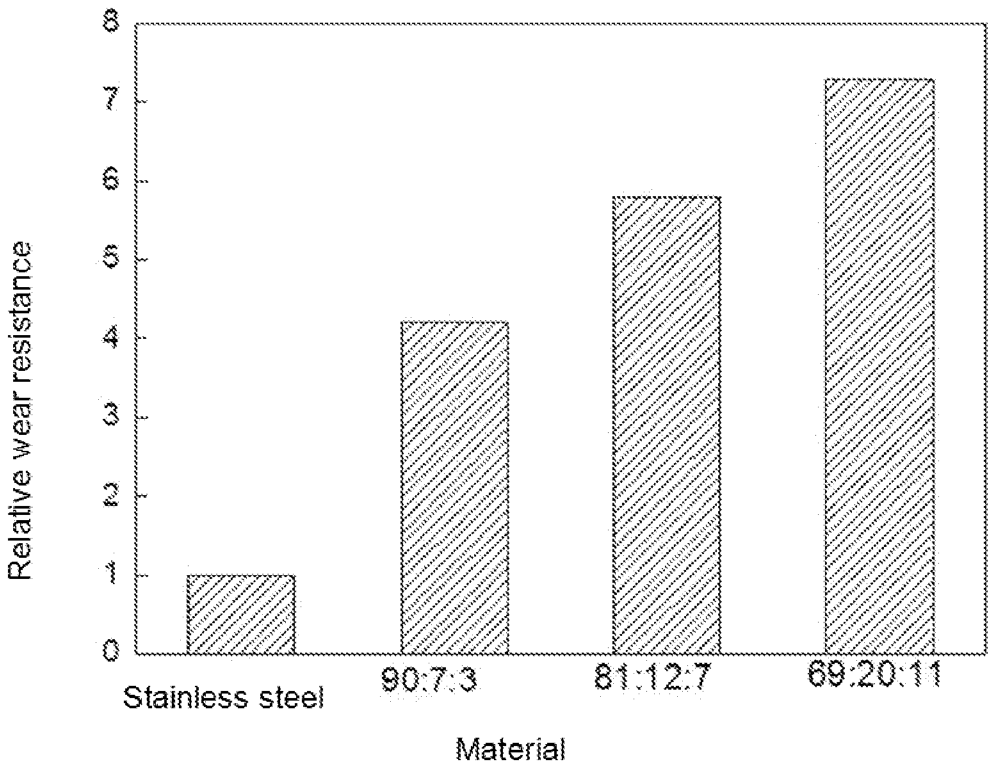
Relative wear resistance
8
7
6
5
4
3
2
1
0
Stainless steel
90:7:3
81:12:7
69:20:11
Material

Fig. 10